

SUPERFUND PROGRAM RECORD OF DECISION



Malvern TCE Superfund Site
Malvern, PA
Chester County, Pennsylvania

NOVEMBER 1997

DECLARATION

SITE NAME AND LOCATION

The Malvern TCE Superfund Site
East Whiteland Township, Chester County, Pennsylvania

STATEMENT OF BASIS AND PURPOSE

This decision document presents the final selected remedial action for the Malvern TCE Superfund Site (Site). The remedial action was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record for the Site.

The Commonwealth of Pennsylvania concurs with the selected remedy.

ASSESSMENT OF THE SITE

Pursuant to duly delegated authority, I hereby determine pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606, that actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to the public, health, welfare, or environment.

DESCRIPTION OF SELECTED REMEDY

The selected remedy described below is the only planned action for the Site. This remedy addresses an alternate water supply, capping of soils and groundwater remediation at the Main Plant Area, excavation and off-Site treatment and disposal of contaminated soils at the Former Disposal Area, and Natural Attenuation of groundwater at the Former Disposal Area.

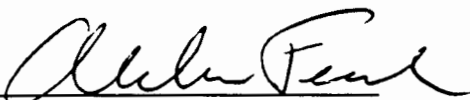
The selected remedy includes the following major components:

- 1) **Water Supply:** Installation of a waterline to prevent contact with groundwater contamination at residences affected or potentially affected by the Site.
- 2) **Main Plant Area Soils:** Installation of a cap to prevent direct contact with contaminated soils at the Main Plant and to reduce the potential for continued migration of these contaminants to the groundwater.
- 3) **Main Plant Area Groundwater Plume:** Extraction and treatment of groundwater via air stripping followed by carbon adsorption or U/V oxidation and subsequent reinjection of treated water to the aquifer to restore the Site groundwater to beneficial use.
- 4) **Former Disposal Area/Mounded Area Soils:** Excavation, off-Site treatment and disposal of contaminated soils to reduce the potential for continued migration of contaminants in these soils to the groundwater.
- 5) **Former Disposal Area/Mounded Area Groundwater Plume:** Implementation of a Natural Attenuation program to monitor reduction of contaminant concentrations in groundwater to Maximum Contaminant Levels.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment and is cost effective. EPA believes that the selected remedy will comply with all Federal and State requirements that are legally applicable or relevant and appropriate to the remedial action. The selected remedy utilizes a permanent solution to the maximum extent practicable and satisfies the statutory preference for a remedy that employs treatment that reduces toxicity, mobility, or volume.

Because this remedy will result in hazardous substances remaining on-Site above health-based levels, a review by EPA will be conducted within five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.


Abraham Ferdas, Acting Director
Hazardous Waste Management Division
Region III

11/26/97
Date

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RECORD OF DECISION

MALVERN TCE SITE

PART II - DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

The Malvern TCE Superfund Site (Site) is located in East Whiteland Township, Chester County, Pennsylvania (Figure 1). The Site is owned and operated by Chemclene Corporation (Chemclene), which presently sells hydraulic oil and industrial cleaning solvents from the 258 North Phoenixville Pike location. The Site encompasses approximately 5 acres along the southeast side of Bacton Hill, and includes a Main Plant Area connected to a Former Disposal Area by a narrow meadow corridor. A Transcontinental natural gas pipeline right-of-way extends along the southern boundary of the Site, with residential areas and areas with natural forestation and vegetation bordering the property to the west, north and east (Figure 2).

Existing facilities at the main plant include a former distillation building, a storage building which has collapsed, a concrete pad area, an open garage, and seven above-ground storage tanks (Figure 3). One 8,000-gallon tank contains hydrogen peroxide and the other six above-ground storage tanks are currently empty. From 1952 until 1992, Chemclene Corporation sold and reclaimed industrial cleaning solvents including trichloroethene (TCE); 1,1,1-trichloroethane (1,1,1-TCA); perchloroethylene (PCE, also called tetrachloroethene); and methylene chloride (MEC). These solvents were used by local industries for degreasing metal parts and other cleaning purposes. Chemclene used a distillation process to remove impurities from the chlorinated solvents. The distilled solvents were then returned to customers for reuse.

The end products of processing waste solvents are the reclaimed solvents and chlorinated still bottoms. The chlorinated waste solvents are listed hazardous wastes pursuant to the Resource Conservation and Recovery Act (RCRA) and therefore, the resulting still bottoms are listed hazardous waste. Prior to 1976, Chemclene reportedly buried drums containing the still bottom sludges from the distillation process in the Former Disposal Area and Mounded Area, approximately 1,900 feet southwest of the main plant. The Former Disposal Area consists of two unlined earthen pits, each approximately 30 feet by 50 feet by 15 feet deep. This area is currently secured by an 8-foot high chain link fence. The Mounded Area, located on the western edge of the Former Disposal Area, is approximately 8 feet wide by 150 feet long.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

In the spring of 1980, TCE was detected in groundwater from several wells in the vicinity of the Chemclene facility. At this time, Chemclene Corporation began sampling domestic wells in the immediate vicinity of the property. Private domestic wells and on-Site monitoring wells were sampled by Pennsylvania's Department of Environmental Resources (PADER) and Chemclene in June 1980 and July 1981. Analytical results revealed contamination of the underlying aquifer with chlorinated ethenes and related compounds. TCE was detected in wells at concentrations up to 12,600 micrograms per liter (ug/l), far exceeding the Maximum Contaminant Level (MCL) of 5.0 ug/l. The Site was listed on the National Priorities List (NPL) in September 1983. The contaminated home wells were located south of the Former Disposal Area, with several located in the Hillbrook Circle residential development. Chemclene furnished activated carbon filter units to 20 residential wells within the Hillbrook Circle Development and conducted periodic sampling of home wells in accordance with its Domestic Well Management Plan until November 1994. In February 1995, EPA assumed control of maintenance activities of the carbon filter units and periodic sampling of the home wells, after it was determined that Chemclene was not following the procedures outlined in its Domestic Well Management Plan. In August 1995, several of the filter systems were upgraded by EPA in response to analytical results from residential well samples that showed contamination was passing through the existing filters into the homes.

In addition to the installation of carbon filters, Chemclene conducted removal actions following the detection of soil and groundwater contamination in 1980. Debris and approximately 300 drums were removed from the Former Disposal Area excavations in a prolonged remedial effort from 1981 to 1984. Soils underlying the Former Disposal Area were excavated to a depth of 15 feet and transported for disposal at a RCRA permitted disposal facility. Additional drums were removed from the Mounded Area in late 1990; however, contaminated soil was left in place.

Four underground storage tanks (USTs) were removed from the main plant in 1986. Soil samples collected from below the excavation grade of the tanks exhibited elevated concentrations of TCE, PCE, and 1,1,1-TCA. In addition, elevated levels of volatile organic contaminants (VOCs) were detected in soil gas samples collected outside the distillation building in the Main Plant Area. These contaminant levels are believed to be related to Chemclene's past practices of discharging contaminated condensate from the recycling distillation process directly onto the ground surface.

As an operating facility, Chemclene Corporation entered into a Corrective Action Order with EPA in 1987. A RCRA Facilities Investigation (RFI) Work Plan was approved for the Site in 1989. In July 1992, Chemclene withdrew its RCRA Part B Application as a treatment and storage facility, and stopped accepting waste solvents for reclamation. Chemclene continues to operate a hauling operation and sells hydraulic fluid, raw TCE, and hydrogen peroxide from the

Site. This operation is regulated by the East Whiteland Township Fire Marshal's office.

Chemclene failed to complete the RCRA RFI and implement interim corrective measures. As a result, EPA began considering the Site under the Superfund remedial program in November 1993. All existing data was compiled and a report was developed entitled Data Summary Report, April 1995. Based on EPA's review of the existing information, data gaps were identified and EPA conducted a Remedial Investigation (RI) to complete the necessary data gathering at the Site. The RI was completed in January 1997 and the Feasibility Study (FS) in June 1997. The Proposed Plan for a comprehensive Site clean up was issued in June 1997.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

The documents which EPA used to develop, evaluate, and select a remedy for the Site have been maintained at the Chester County Library, 400 Exton Square Parkway, Exton, PA and at the EPA Region 3 Office, Philadelphia, PA.

The Proposed Plan was released to the public on June 23, 1997. The notice of availability for the RI/FS and Proposed Plan was published in the *Daily Local News* on June 23, 1997. A 30-day public comment period began on June 23, 1997 and was initially scheduled to conclude on July 23, 1997. By request, the public comment period was extended until September 2, 1997.

A briefing for the East Whiteland Township Board of Supervisors and a public meeting were held during the public comment period on July 14, 1997. At the meeting, representatives from EPA answered questions about the Site and the remedial alternatives under consideration. Approximately 50 people attended the meeting, including residents from the impacted area, potentially responsible parties, and news media representatives. A summary of comments received during the comment period and EPA's responses are contained in Part III of this document.

IV. SCOPE AND ROLE OF RESPONSE ACTIONS

This final selected remedy addresses the threats posed by the release of hazardous substances at the Site. The primary objective of the remedy described in this ROD is to reduce or eliminate the potential for human or ecological exposure to contaminated soil and groundwater at the Site. The selected remedy outlined on pages 52 to 64 of this ROD will comprehensively address the risks posed by the release or threat of release of hazardous substances from the Site. The concentrations of chemicals in the two groundwater plumes exceed the MCLs set under the Safe Drinking Water Act, 42 U.S.C. §§ 300(f) to 300 (j-26). In addition, this remedial action addresses soils at the Former Disposal Area.

V. SUMMARY OF SITE CHARACTERISTICS

A. Topography

The Site is located in eastern Chester County, Pennsylvania, in the Piedmont Physiographic Province of the Appalachian Highlands. Topography in the county is characterized by uplands composed of Precambrian igneous and metamorphic crystalline rocks that have weathered into rolling hills. These uplands are bisected by the Chester Valley, the county's most prominent topographic feature, which is underlain by deeply eroded carbonate rocks. The Chester Valley trends east/northeast across the county.

The Site is situated in the northern edge of the Chester Valley adjacent to Bacton Hill. The valley floor has gentle relief with elevations ranging from 350 to 400 feet above mean sea level (MSL). Topography at the Site ranges from 395 feet MSL in the north portion of the Former Disposal Area to 360 feet MSL in the area around the main plant. Bacton Hill defines the north edge of the valley around the Site and is underlain by the Cambrian age Chickies Quartzite, a formation that is comparatively resistant to weathering and forms ridges.

B. Climate

The climate in Chester County is humid, temperate and continental with fairly mild winters. Average monthly temperatures range from 32°F in January to 77°F in July (National Oceanic and Atmospheric Administration, Climatological Data from Conshohocken Station). The average annual temperature, based on a 100-year record through 1955 is 52.2°F. The absolute minimum and maximum temperatures for the same time period are -15°F and 105°F respectively.

Precipitation in Chester County is evenly distributed throughout the year, with a difference of about 1.2 inches between the wettest month (July) and the driest month (October). Most of the rainfall in the warm seasons occurs as showers and thunderstorms. An average of thirty storms occur each year, producing considerable erosion and local flooding when infiltration capacity is exceeded and surface drainage systems are near maximum capacity. Flooding problems are exacerbated by the increase in impermeable surfaces associated with commercial development of the area. The average annual groundwater recharge to underlying carbonate rocks in the Chester Valley is 21 inches, approximately 45 percent of the total precipitation.

The average amount of snow falling on Chester County ranges from 20 to 30 inches per year, but usually remains as ground cover only for several days per year. During winter months, precipitation events are usually more prolonged and less intense than in the summer. Runoff is

reduced in the winter and groundwater recharge is enhanced, unless the ground surface is frozen. Lower winter temperatures reduce evaporation and plants become dormant, greatly reducing water losses through transpiration.

C. Hydrology

The Site is located in the Chester Valley, underlain by carbonate and clastic rocks of Cambrian and Ordovician age. The immediate area of the Site is underlain by the Ledger Dolomite and Elbrook Limestone Formations. Recent overburden deposits across the Site consist of fine-grained soils overlying bedrock. Overburden deposits range in thickness from 30 to 120 feet.

The bedrock aquifer underlying the Site is generally unconfined and is recharged by local precipitation. Groundwater flows through a network of interconnected secondary openings that include joints, faults, bedding planes, and fractures. In May 1996, the mean depth to groundwater at the Main Plant Area was 70 feet.

Groundwater at the Main Plant Area flows to the northeast toward the Catanach Quarry at a gradient of 0.02 ft/ft. The regional potentiometric surface shows that there is a groundwater divide located between the Main Plant Area and the Former Disposal Area near monitoring well CC-11. Water level data suggests that the divide may move as a function of quarry activity and hydrogeologic conditions. Based on the hydraulic gradient and coefficients of hydraulic conductivity derived from the results of aquifer tests at monitoring wells CC-19 and CC-21, groundwater flows at a relatively rapid velocity of 0.66 ft/day.

Groundwater beneath the Former Disposal Area/Mounded Area flows to the southwest toward the Hillbrook Circle development under a relatively flat gradient (0.001 ft/ft). Groundwater velocities range up to 5 ft/day. (See Figure 4)

This aquifer is a current drinking water source. As recently as 1992, the Philadelphia Suburban Water Company withdrew water from this aquifer at a production well on Phoenixville Pike to supply local residents on public water. In addition, Great Valley High School operated a well in the Ledger Aquifer to provide water for drinking and irrigation.

D. Land Use

The predominant land uses in East Whiteland Township are open space, encompassing 32 percent of total township acreage, and single-family residences and agriculture, each making up approximately 14 percent. Much of the open area consists of forested uplands and meadows. Open space and agricultural lands have been decreasing since 1950, as the percentage of commercial and residential land increases.

VI. NATURE AND EXTENT OF CONTAMINATION

This section discusses the nature and extent of contamination in the soils (surface and subsurface), groundwater, and surface water and sediment at the Site. This discussion is

presented by area: Main Plant Area, Former Disposal Area/Mounded Area, and Potential Disposal Area. Within each of these areas, the media (soil-surface and subsurface, groundwater, surface water and sediment) is then discussed. Domestic well data are presented in the subsection discussing groundwater contamination at the Former Disposal Area/Mounded Area.

A. Main Plant Area (MPA)

SURFACE SOIL

Twenty-five surface soil samples were collected at the Main Plant Area in the spring of 1996. Samples were collected from 0 to 6 inches. Samples were collected from background locations (SS-1, SS-2, and SS-41 through SS-44) and in areas of suspected contamination based on the results of previous investigations. These areas include the loading dock area (SS-4 through SS-6); the former UST area (SS-3, SS-7 through SS-9); the existing above-ground storage tank area (SS-10 through SS-16); and the fill area west of the storage building (SS-17 through SS-20).

Volatile Organic Compounds (VOCs)

VOCs detected in the surface soils were comprised mostly of chlorinated aliphatic hydrocarbons (CAHs) including: 1,2-dichloroethane (1,2-DCA), total 1,2-dichloroethene (total 1,2-DCE), MEC, PCE, 1,1,1-TCA, and TCE. Figure 5 shows the contaminant distribution of VOCs for the surface soil samples collected at the Main Plant Area and indicates where Soil Screening Levels (SSLs) were exceeded. Acetone and MEC were detected in some samples at concentrations not substantially above levels detected in laboratory quality control blanks. Excluding these data, VOCs were detected in 13 of the 25 surface soil samples collected at the Main Plant Area.

Total VOC concentrations range from 2 ug/kg to 235 ug/kg (SS-07). TCE was detected in 7 samples with concentrations ranging from 2 ug/kg (SS-08) to 81 ug/kg (SS-07). PCE was detected in 12 samples with concentrations ranging from 2 ug/kg to 56 ug/kg (SS-12). MEC was detected in all 25 surface soil samples collected at the Main Plant Area. Of the 25 samples, only one, SS-07 (80 ug/kg), was detected at a concentration substantially above the level detected in the laboratory quality control blank. Table 1 lists the maximum concentrations of contaminants detected in the surface soil at the Main Plant Area. See Figure 5 for distribution of VOCs in surface soil.

VOC screening levels were exceeded in the surface soil for 1,2-DCA, MEC, PCE and TCE at concentrations of 24 ug/kg, 80 ug/kg and 81 ug/kg, respectively.

Semivolatile Organic Compounds (SVOCs)

Eighteen SVOCs were detected in the surface soils at the Main Plant Area. SVOCs were detected in 15 of the 25 surface soil samples collected at the Main Plant Area at concentrations substantially above the laboratory quality control blanks. Total SVOCs concentrations range from 11 ug/kg (SS-10) to 11,103 ug/kg (SS-11) (Figure 6). The total SVOC concentration of 11,103 ug/kg detected at SS-11 is comprised mainly of bis(2-ethylhexyl) phthalate at 11,000

ug/kg. Fifteen SVOCs were detected in the sample SS-15, collected adjacent to the aboveground storage tank area. Total SVOC concentrations for SS-15 were 8,660 ug/kg. Excluding bis(2-ethylhexyl)phthalate, no SVOC was detected in more than 7 of the 25 samples collected. Figure 6 also shows the distribution of the SVOCs in the surface soil at the Main Plant Area, and indicates samples where criteria have been exceeded.

Inorganics

Twenty-two inorganics (total metals and cyanide) were detected in the surface soils in the Main Plant Area. Eighteen metals were detected in 19 or more of the surface samples collected at the Main Plant Area. The highest concentrations of nine metals were detected at SS-17, in the fill area adjacent to the rear storage building. Table 1 presents the maximum concentrations detected in the surface soil at the Main Plant Area.

Concentrations of metals in the background samples (SS-1, SS-2, SS-41, SS-42, SS-43, and SS-44) were comparable to Main Plant Area samples SS-3 through SS-20. SSLs were exceeded for barium, chromium, nickel and thallium in the surface soils. Twenty-three surface soil samples with concentrations up to 140 mg/kg, exceeded the SSL (32 mg/kg) for barium. Nineteen samples with concentrations up to 113 mg/kg exceeded the SSL (19 mg/kg) for chromium. SSLs were exceeded in 10 samples for nickel and in one sample for thallium.

The pervasive appearance of barium and chromium in all the samples, including background samples, indicates these metals may occur naturally in the surface soil at the Main Plant Area.

Elevated iron and manganese concentrations in soil are not considered to originate from the waste disposal activities at the Main Plant Area. Most of the subsurface soil at the Site is stained brick-red to red-brown, indicating that the soil contains percentage amounts (of the bulk mineral matrix) of ferric hydrous oxide minerals. This type of soil is common world-wide in mature carbonate terrains and is not related to contamination by synthetic organic compounds.

Concentrations of iron and manganese in soil will decline in the presence of significant amounts (greater than 1.0 mg/l) of Site-related contamination. Anaerobic bacteria utilize iron and manganese as electron acceptors in the degradation of CAHs and aromatic hydrocarbons. Often, in soil extensively contaminated with VOCs and SVOCs, iron and manganese hydrous oxides have been completely leached away leaving a reduced mineral assemblage. Soil color is usually altered from red-brown to dark-gray.

SUBSURFACE SOILS

Twelve soil borings were installed in the spring of 1996 at the Main Plant Area (Figure 7). The total depth of the soil borings ranged from 42 feet to 102 feet. Overburden deposits range in thickness from approximately 30 feet (CC-6) to greater than 100 feet (MPA-8, MPA-9). Overburden deposits consists of reddish brown and whitish-gray silts and sands interbedded with clays, silty clays and clayey silts. Gravel and pebble size limestone/dolomite clasts are found throughout the overburden deposits. Silt and sand lenses beneath the Main Plant Area range in thickness from less than 1 foot up to 40 feet (MPA-8 and MPA-9).

Forty subsurface soil samples were collected for laboratory analysis from 12 borings at the Main Plant Area. Samples were collected from 2-foot intervals in each boring.

Volatile Organic Compounds

VOCs detected in the soil samples collected at the Main Plant Area included: 1,1-dichloroethene (1,1-DCE), 1,1-dichloroethane (1,1-DCA), Total 1,2-DCE, 1,2-DCA, 1,1,1-TCA, TCE, 1,1,2-TCA, 1,1,2,2-tetrachloroethane (1,1,2,2-PCE), PCE, total xylene, toluene, ethylbenzene, benzene, 2-butanone, 4-methyl-2-pentanone. VOCs considered as possible laboratory contaminants included MEC, acetone, and chloroform. TCE was detected in 22 of the samples ranging in concentrations from 1 to 420,000 ug/kg (MPA-8, at 25-27 foot depth). Total 1,2-DCE was detected in 13 of the samples ranging in concentrations from 1 to 4,000 ug/kg (MPA-6 at 10-12 foot depth). PCE was detected in 12 samples from 2 to 270,000 ug/kg MPA-6, 10-12 feet depth). Table 2 outlines the maximum concentrations detected in the subsurface soil at the Main Plant Area, and the location of the highest detection by parameter.

In borings MPA-1, MPA-11 and MPA-12, designated as background borings, TCE was only detected (3 ug/kg) in the 10-12 foot sample at MPA-1. Borings MPA-2 and MPA-3 are located in the loading dock area where distillate condensate was reportedly disposed onto the ground surface. Low levels of TCE, PCE and 1,1,2-TCA were detected in MPA-3. Generally, VOC concentrations increased (by 1 to 2 orders of magnitude) with depth at MPA-2. Total VOCs were detected at 1277 ug/kg in the MPA-2 at the 50-52 foot depth interval. MEC data were flagged as possibly resulting from laboratory contamination in each of the samples were detected, at concentrations up to the maximum of 480 mg/kg in MPA-2 at the 50-52 foot depth.

Borings MPA-4, MPA-5, MPA-6, and MPA-7 are adjacent to the former UST area. Low levels of VOCs (<20 ug/kg) were detected in MPA-5. Moderate levels of VOCs were detected in samples from MPA-4 and MPA-7. Total VOCs at MPA-7 were detected at less than 100 ug/kg in both samples. Total VOCs in MPA-4 at the 12-14 foot depth were detected at 260 ug/kg, and at lower concentrations in the other samples. VOCs were detected in MPA-6 in the 10-12 foot sample at 497,316 ug/kg, including total benzene, toluene, ethylbenzene, and xylene (BTEX) concentrations of 152,052 ug/kg, and PCE at 270,000 ug/kg. The highest concentrations for nine VOCs at the Main Plant Area were detected in MPA-6 at the 10-12 foot interval, which corresponds to the base of the former USTs excavations. Seven VOCs from this sample exceeded screening levels.

Borings MPA-8 and MPA-9 are adjacent to the above ground storage tank area. Moderate to high levels of VOCs were detected in MPA-8 at the 25-27 foot depth and MPA-9 at the 100-102 foot depth. Total VOCs detected in MPA-9 at the 100-102 foot depth were at concentrations of 869 ug/kg, with TCE as the main component at 780 ug/kg. MEC was also detected in MPA-9 samples at concentrations up to 140 ug/kg. Total VOCs were detected in MPA-8 at the 25-27 foot interval at concentrations of 625,214 ug/kg, with TCE as the main component at 420,000

ug/kg.

Boring MPA-10 is adjacent to the storage shed. Moderate levels of VOCs were detected in the MPA-10, 6-8 ft. sample at concentrations of 871 ug/kg, with total xylene as the main component at 780 ug/kg. MEC was also detected in MPA-10 at the 6-8 foot interval at 160 ug/kg.

Semivolatile Organic Compounds

Twenty-one SVOCs were detected in the subsurface soil samples at the Main Plant Area. The distribution of SVOCs varied significantly with most SVOCs being present in five or fewer samples. Of the maximum detected concentrations for the SVOCs in the Main Plant Area, eighteen were detected in the MPA-6 at the 10-12 foot interval. The total SVOC concentration in this sample is 18,070 ug/kg. Only the bis(2-ethylhexyl) phthalate concentration exceeded the soil screening level. The SVOCs detected are constituents of petroleum hydrocarbons and probably originated from one of the USTs. Table 2 outlines the maximum concentration detected and the number of times each analyte was detected.

Inorganics

Twenty-one inorganics (total metals and cyanide) were detected in the subsurface at the Main Plant Area. Sixteen metals were detected in 34 or more samples. Table 2 outlines the maximum concentration detected and the number of times each analyte was detected.

SSLs were exceeded for arsenic, barium, chromium, and nickel in subsurface samples at the Main Plant Area. The SSL for barium (32 mg/kg) was exceeded in eleven samples with concentrations up to 287 mg/kg. Seven subsurface samples exceed the SSL for nickel (21 mg/kg) with concentrations up to 62.3 mg/kg. The SSL for chromium was exceeded in four samples and the SSL for arsenic was exceeded in one sample.

GROUNDWATER

A groundwater sampling program was conducted in the spring and winter of 1996 to determine the nature and extent of contamination in the groundwater at the Main Plant Area (See Figure 8 for monitoring well locations). This subsection describes the known horizontal and vertical extent of contamination in the groundwater beneath the Main Plant Area. Groundwater contamination is defined by analytical results from a monitoring well sampling event in May 1996, and a time-related sampling during 24-hour aquifer tests at CC-19 and CC-21.

Five existing and four newly-installed monitor wells and one commercial well (CC-JO) were sampled in the spring and winter of 1996. Eleven samples were collected and analyzed for organics, metals (total and dissolved), cyanide, and water quality parameters from CC-2, CC-3, CC-6, CC-7, CC-13, CC-19, CC-20, CC-21, CC-22 and CC-JO. Table 3 and 4 highlight parameters where MCLs have been exceeded in the groundwater for organics, and total and dissolved inorganics.

Volatile Organic Compounds

Twenty-three VOCs were detected in the groundwater monitoring wells at the Main Plant Area with the number of VOCs detected in each well ranging from six to seventeen. VOCs were not detected in the Led-Jo commercial well (CC-JO). Sixteen VOCs were detected in the groundwater at CC-06 and CC-07. The primary contaminants disposed at the Main Plant Area, 1,1,1-TCA, TCE and PCE, were detected in all monitoring wells. The maximum detected concentrations for nine VOCs were detected at CC-06, and maximum detected concentrations for ten VOCs were detected at CC-07. Total VOCs detected at the Main Plant Area range in concentration from 20 ug/l (CC-20) up to 88,732 ug/l (CC-6). Total VOCs detected at CC-07 were 59,881 ug/l. Figure 8 shows the distribution of VOCs and SVOCs in groundwater at the Main Plant Area, including compounds that exceeded MCLs.

Primary MCLs were exceeded for eleven VOCs including: 1,1,1-TCA, 1,1,2-TCA, 1,1-DCE, 1,2-DCA, carbon tetrachloride, chloroform, cis-1,2-DCE, MEC, PCE, TCE and vinyl chloride. The MCL for TCE was exceeded in groundwater at all nine wells at the Main Plant Area with concentrations ranging from 8.5 ug/l to 53,900 ug/l. The MCL for PCE was exceeded in seven wells with concentrations ranging from 5.9 ug/l to 7110 ug/l.

Monitoring wells on the eastern (CC-02) and western (CC-20 and CC-22) edge of the Main Plant Area contain low levels of VOC contamination. Hydraulically, CC-2 is the most upgradient well at the Main Plant Area, but displays up to 65 ug/l total VOCs, including TCE above the MCL (Figure 10). The four most contaminated wells are within the Main Plant Area in the former UST area and the condensate distillate disposal area. VOC concentrations appear to decrease radially outward from wells CC-03, CC-06, CC-07, and CC-13 as shown in Figure 9. VOC concentrations in CC-13 are an order of magnitude less than the adjacent wells CC-06 and CC-07. CC-13 monitors a deeper interval (124 to 178 ft below ground surface) than adjacent wells CC-06 and CC-07. The vertical extent of contamination decreases with depth and with horizontal distance from the main contaminant source area. The monitoring wells that are in or adjacent to the main contaminant source area (CC-03, CC-06, CC-07 and CC-13) have two to three orders of magnitude higher concentrations than the monitoring wells that are located outside the Main Plant Area (CC-19 through CC-22) or at a greater distance from the source area (CC-02).

The contaminant plume at the Main Plant Area extends approximately 120 feet from the highly contaminated core defined by wells CC-6 and CC-7 to a projected isopleth of 10 ug/l (Figure 10). Monitor wells at the Main Plant Area are not well situated to characterize the longitudinal

boundary of the plume. The contaminant plume is approximately 200 feet wide. The total length of the plume is not known at this time.

Semivolatile Organic Compounds

Low levels of SVOCs (less than 3 ug/kg) were detected in the groundwater at the Main Plant Area and at CC-JO. SVOCs detected in three separate wells at the Main Plant Area include 1,2-dichlorobenzene, phenanthrene, and di-n-butyl phthalate. Bis(2-ethylhexyl) phthalate was detected in CC-JO. SVOCs in the groundwater did not exceed MCLs.

Inorganics

Twenty-four inorganics (total metals and cyanide) were detected in the groundwater at the Main Plant Area and CC-JO.

Primary MCLs were exceeded at CC-06 for total concentrations of antimony, barium, beryllium, cadmium, chromium, nickel and thallium. Secondary MCLs and action levels were exceeded for aluminum (total), iron (total and dissolved), lead (total) and manganese (total and dissolved) for a number of wells. Table 4 shows which metals exceeded MCLs in the groundwater. the Main Plant Area.

DNAPL Investigation

The RI contained an integrated approach to assess the Main Plant Area for the potential distribution of DNAPLs using existing analytical and field observation data. Both groundwater and soil quality data were evaluated to determine the presence of DNAPLs using various screening methods. These techniques included EPA guidance procedures for evaluating groundwater quality data, a method for evaluating analytical data from soils following Feenstra, et. al. (1991), head space screening results from soil samples, and visual observations of groundwater samples using a nonvolatile, hydrophobic dye.

As DNAPLs often accumulate in small pools in the vadose and saturated zones, the likelihood of encountering DNAPLs in a soil sample from a vertical boring or groundwater from a conventional monitor well is remote, unless the boring is drilled directly through the DNAPL pool. Consequently, screening methods that evaluate contaminant concentrations in several different media with several techniques must be employed to determine the potential occurrence of DNAPLs. The database consisted of groundwater and soil analytical data, headspace screening results and a dye survey from the latest round of groundwater sampling.

Results of the screening analysis indicated that DNAPLs may occur in, or upgradient of monitor wells CC-6, CC-7, and CC-13. All three wells are located directly below the former UST area. Soil quality data indicated DNAPLs may occur in the vadose zone at 10-12 feet below grade in MPA-6, and 25-27 feet below grade in MPA-8. Headspace correlation based on a headspace-threshold measurement of 150 ppm identified potential DNAPLs in borings MPA-2, 3, 4, 6, and

8.

B. Former Disposal Area/Mounded Area (FDA/MA)

The source of soil contamination detected at the Former Disposal Area/Mounded Area were buried drums containing still bottoms from Chemclene's solvent recycling process. Approximately 300 drums and adjacent soils were excavated and removed from the area for disposal at an approved facility between 1981 and 1984. Chemclene removed a second cache of drums from the Mounded Area in 1990; however, contaminated soil was left in place.

SURFACE SOIL SAMPLES

In April 1996, a total of 21 surface soil samples (including QA/QC samples) were collected from the Former Disposal Area/Mounded Area at depths between 0 and 6 inches below ground surface. Surface soil samples were submitted for VOC and SVOC, metal, and cyanide analyses.

Of the surface soil sample locations in the Former Disposal Area/Mounded Area (designated SS-21 through SS-40), nine locations were within the fenced area, four were within the Mounded Area, and the remaining seven were northwest and southeast of the fenced excavation area (Figure 11).

Volatile Organic Compounds

PCE was the most commonly detected Site-related contaminant in the surface soil samples. PCE was detected in ten samples, with a highest concentration of 130 ug/kg in SS-28, and concentrations of less than 10 ug/kg in the remaining nine samples. PCE was the only Site-related VOC detected in excess of the SSL of 40.0 ug/kg (Figure 11). Other organic contaminants detected at low levels in surface soils were 1,1,1-TCA, 1,2-DCE, and TCE. Distribution of VOCs in surface soils and the VOCs that exceed SSLs are shown in Figure 10.

Semivolatile Organic Compounds

Of the surface soil sampling locations at the Former Disposal Area/Mounded Area, bis(2-ethylhexyl)phthalate was detected in all but SS-21 and SS-33, at levels ranging from 55 (SS-35) to 2400 ug/kg (SS-25). Bis(2-ethylhexyl)phthalate was the only SVOC detected in 15 of the 20 samples, and was also detected in field blanks submitted with the surface soil samples. The distribution of SVOCs in the surface soil at the Former Disposal Area/Mounded Area is shown in Figure 12.

The highest total concentration of SVOCs was detected in sample SS-27 (1,747 ug/kg) in the Mounded Area. SVOCs were not detected in excess of the SSLs.

Inorganics

The inorganic composition of the Former Disposal Area/Mounded Area surface soils is considered to be generally representative of background conditions, although several metals were detected at levels exceeding SSLs. These metals were: barium, cadmium, chromium, nickel, selenium, and thallium. Barium was detected above the SSL of 32 mg/kg in all 21 of the surface soil samples, at levels ranging from 36.3 (SS-32) to 157 mg/kg (SS-40). Cadmium was detected above the SSL of 6.0 mg/kg in three samples: SS-23 at 8.6 mg/kg; SS-26 at 36.4 mg/kg; and SS-37 at 10 mg/kg. Chromium was detected above the SSL of 19.0 mg/kg in 16 samples, with a maximum concentration of 40.9 mg/kg detected in SS-28. Nickel was detected above the SSL of 21 mg/kg in three samples: SS-26 at 25 mg/kg; SS-28 at 21.9 mg/kg; and SS-31 at 23.5 mg/kg. Selenium was detected above the SSL of 3.0 mg/kg in one sample, SS-40, at 3.9 mg/kg. Thallium was detected above the SSL of 0.4 mg/kg in three samples: SS-25 at 1.6 mg/kg; SS-26 at 3.1 mg/kg; and SS-27 mg/kg. Cyanide was detected in two of the surface soil samples: SS-24, at 0.68 mg/kg; and SS-36, at 21.5 mg/kg. There are no applicable SSLs for cyanide in soils.

SUBSURFACE SOIL SAMPLES

The subsurface at the Former Disposal Area/Mounded Area is defined by a total of six soil borings (designated FDA-1 through FDA-6), drilled in March 1996 to depths ranging from 27 to 62 feet below ground surface (Figure 13). The subsurface consists of recent unconsolidated overburden deposits overlying the Cambrian Ledger Dolomite. The Ledger Formation was encountered only in boring FDA-4, at a depth of approximately 60 feet below ground surface. Overburden deposits generally consist of silts and sands interbedded with clays, silty clays, and clayey silts. Subangular limestone/dolomite clasts are found throughout the overburden deposits.

Volatile Organic Compounds

Eighteen VOCs were detected in 19 subsurface soil samples at the Former Disposal Area/Mounded Area. Most VOCs were detected in nine or fewer samples. PCE, MEC, and acetone were detected more frequently. PCE was detected in 16 of the 19 subsurface samples although concentrations in nine samples may have resulted from laboratory blank contamination. Concentrations of total VOCs (excluding those detected in laboratory quality control blanks) range from 3 ug/kg (FDA-2 at 25-27 foot) to 505,000 ug/kg (FDA-5 at 8-10 foot). VOCs that may be present from laboratory contamination include 1,2-DCE, MEC, acetone, PCE, and xylenes. Soil samples collected between 2 and 10 ft below ground surface at FDA-3 and FDA-5 and between 3 and 22 ft below ground surface at FDA-4 exhibited total VOC concentrations in excess of 1,000 ug/kg.

The highest concentration of an individual VOC was PCE at 410,000 ug/kg in FDA-5 at 8-10 feet. This maximum concentration exceeded the SSL (40 ug/kg) for PCE by several orders of magnitude. Maximum detected concentrations for ethylbenzene, MEC, PCE, TCE, and xylenes were also detected in this sample. VOCs that were commonly detected at concentrations above SSLs included PCE, TCE, 1,1,1-TCA, 1,1,2,2-TCA, 1,1-DCA, 1,2-DCE, 1,2-DCA, and xylenes. Borings FDA-4 and FDA-5 are located in or adjacent to the Mounded Area. VOC contamination at the Mounded Area generally decreases with depth. Total VOCs in samples

deeper than 20 feet below grade at the Former Disposal Area/Mounded Area are less than 100 ug/kg.

Low levels of VOC contamination were detected at soil borings FDA-1, FDA-2, and FDA-6, however, these contaminants were also detected in laboratory quality control blanks and appear to result from laboratory rather than Site-related contamination.

Semivolatile Organic Compounds

SVOCs were detected in 11 of the 19 subsurface soil samples collected from the Former Disposal Area/Mounded Area. These samples were from borings FDA-3, FDA-4, and FDA-5. The most commonly detected SVOCs, including 2-methylnaphthalene, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, naphthalene, and phenanthrene were detected in 8 to 11 samples. The remaining SVOCs were detected in fewer than 4 samples each. Total SVOC concentrations exceeding 1,000 ug/kg were detected in samples from depths of 2-22 feet at FDA-3, FDA-4, and FDA-5.

Inorganics

Thirteen metals were detected in the 19 subsurface soil samples collected at the Former Disposal Area/Mounded Area. The list of metals in the subsurface soils is generally similar to that of the surface soils. SSLs for barium, chromium, and thallium were exceeded for one or more of the subsurface soil samples. Barium was detected above the SSL of 32 mg/kg in FDA-2 at 20-22 feet (33.2 mg/kg); and in FDA-4 at 8-10 feet (60.4 mg/kg). Chromium was detected above the SSL of 19.0 mg/kg in FDA-1 at 25-27 feet (19.9 mg/kg); FDA-2 at 20-22 feet (20.1 mg/kg); FDA-3 at 12-14 feet (22.6 mg/kg); FDA-3 at 8-10 feet (21.3 mg/kg); and FDA-4 at 8-10 feet (20.7 mg/kg). Thallium was detected above the SSL of 0.4 mg/kg in four samples: FDA-1 at 10-12 feet (0.8 mg/kg); FDA-3 at 12-14 feet (0.73 mg/kg); FDA-4 at 20-22 feet (1.3 mg/kg); and FDA-4 at 3-5 feet (2.2 mg/kg). However, all thallium levels, except that of FDA-3 were detected at similar levels in the field quality control blanks.

GROUNDWATER

This subsection describes the known horizontal and vertical extent of contamination detected in groundwater underlying the Former Disposal Area/Mounded Area. Groundwater contamination in this area is defined by analytical results for groundwater samples collected from a total of nine monitoring wells. Concentrations of detected compounds are compared with the corresponding MCLs.

Groundwater samples were collected from existing Former Disposal Area/Mounded Area monitor wells (CC-5, -9, -10, -11, and -14) and newly installed wells (CC-15 through CC-18) in April and May 1996. Unfiltered groundwater samples were analyzed for VOCs, SVOCs, total metals, and cyanide, and for alkalinity, chloride, low concentration metals, nitrate, nitrite, silica, sulfate, total dissolved solids (TDS), and total organic carbon. Filtered groundwater samples were analyzed for dissolved metals. Conventional water quality parameters (alkalinity, nitrate,

silica, sulfate, TDS) were used to characterize background groundwater chemistry.

Volatile Organic Compounds

Twenty VOCs were detected in the groundwater at the Former Disposal Area/Mounded Area. Total VOC concentrations ranged from a low of 8.1 ug/l in CC-11 to a high of 3,298 ug/l in CC-5. Figure 14 presents the distribution of VOCs in the monitoring wells at the Former Disposal Area/Mounded Area. VOCs that exceeded groundwater MCLs are underlined.

The following VOCs were detected at levels exceeding the MCLs: 1,1-DCE at wells CC-5, CC-15, and CC-16; 1,2-DCA at wells CC-5 and CC-16; cis-1,2-DCE at wells CC-5, CC-16, and CC-17; PCE at wells CC-5, CC-9, CC-15, CC-16; and TCE at wells CC-5, CC-9, CC-14, CC-15, CC-17, and CC-18.

An isopleth map presenting total VOC concentrations was created with analytical data from the May 1996 monitor well sampling event and June 1996 domestic well sampling event. The domestic well data are discussed in the next section. The monitoring wells exhibiting the highest concentration of VOCs (CC-5, CC-15, CC-16, and CC-17) are configured in a line extending along the south and southwest portion of the Former Disposal Area/Mounded Area. VOC contamination in CC-5 is 1 to 2 orders of magnitude higher than the surrounding wells CC-9, CC-10, CC-15, CC-16, CC-17, and CC-18, all of which are within a distance of 50 to 250 feet from CC-5. The VOC contaminant plume, centered at CC-5, extends from the Former Disposal Area/Mounded Area to the residences along Hillbrook Circle as shown in Figure 15. Due to the relatively flat potentiometric surface in the area encompassing the Former Disposal Area/Mounded Area, contamination appears to spread laterally upgradient as well as migrating downgradient. In this mode of migration, contamination has moved toward CC-14, before migrating downgradient. The plume is elliptical and appears discontinuous in Hillbrook Circle. Total VOC concentrations within the Hillbrook Circle Development are up to 180 ug/l at a distance of 2,100 feet from the Former Disposal Area/Mounded Area.

Semivolatile Organic Compounds

SVOCs were not detected in concentrations above the detection limit in groundwater from the Former Disposal Area/Mounded Area monitor wells.

Inorganics

Total metals that were detected in Former Disposal Area/Mounded Area wells in concentrations in excess of the corresponding MCLs were aluminum at CC-10 and CC-14, beryllium at CC-14, cadmium at CC-11; iron at CC-5, -10, -11, and -14; and manganese at CC-10, -11, and -14. Elevated metal concentrations at CC-11 are the result of low pH (6.42) at this well and represent local background conditions, rather than Site-related contamination.

Of the dissolved metals, iron and manganese levels, both in CC-11, exceeded associated MCLs. Cyanide was not detected in the Former Disposal Area/Mounded Area groundwater samples.

C. Domestic Wells

Groundwater samples were collected from domestic wells in the vicinity of Chemcene during sampling events conducted in June, August, and December of 1995, and of June 1996. Samples were analyzed for VOCs and SVOCs. This subsection presents analytical results from the June 1996 sampling event, and compares total VOC concentrations of unfiltered samples with results of corresponding unfiltered samples from the August 1995 sampling event. Only 15 unfiltered samples (including a duplicate) were collected in August 1995. Only unfiltered data are presented because filtered samples represent the filter efficiency; and in general, only trace or nondetectable levels of VOCs have been detected in domestic wells that have filter systems.

Samples were collected from a total of 49 domestic wells in June 1996. Both unfiltered and filtered samples were collected from 18 of the 49 domestic wells, for a total of 67 samples.

Volatile Organic Compounds

VOCs were detected at concentrations above the detection limits in samples from 20 of the 49 domestic wells during the June 1996. VOCs were detected in both filtered and unfiltered samples from five of the domestic wells. Total VOC concentrations were greater than or equal to 10 ug/l in eight of the 49 domestic wells: DW-6B, 9B, 16B, 36A, 36B, 41B, 57B, and 58B. A maximum total VOC concentration of 289 ug/l was detected in the sample from DW-41B.

Three organic contaminants (1,1-DCE, PCE, and TCE) were detected at levels exceeding corresponding MCLs. A concentration of 18 ug/l of 1,1 DCE was detected in DW-41B, exceeding the MCL of 7.0 ug/l. PCE was detected at or above the MCL of 5.0 ug/l in DW-41B (38 ug/l), DW-58B (14 ug/l), and DW-65B (5.0 ug/l). TCE was detected in excess of the MCL of 5.0 ug/l in the following wells: DW-36B (36 ug/l); DW-41 (140 ug/l); DW-6B (34 ug/l); DW-9B (7.0 ug/l); DW-57B (23 ug/l); DW-58B (110 ug/l); and DW-67B (7.0 ug/l).

As shown in Figure 14, the distribution of VOCs detected in groundwater at the Site is defined by a major plume extending to the southeast from the Former Disposal Area/Mounded Area, and a second area of groundwater contamination to the southeast. These areas of contamination do not form a continuous plume, but are separated by several wells in which VOCs have not been detected. This distribution pattern may be a result of differences in domestic well depth and construction.

Based on June 1996 analytical data, selected wells were compared to results from August 1995, total VOC concentrations had increased in 5 samples, decreased in 8 samples, and remained the same (nondetect) in 2 samples. The highest total VOC concentration in August 1995 was 121 ug/l in well DW-36B, compared with 55 ug/l in the same well in June 1996. Well DW-36B exhibited the greatest change in VOC concentrations between the 2 sampling intervals, with the

other wells showing differences of only a few ug/l from August 1995 to June 1996. Table 5 presents the total VOC concentration of selected domestic wells for August 1995 and June 1996.

Semivolatile Organic Compounds

SVOCs were detected at concentrations above the detection limit in samples from four of the 49 domestic wells. Bis(2-ethylhexyl)phthalate was detected in DW-36B (8 ug/l); in DW-52B (16 ug/l); and in DW-55B (23 ug/l). Di-n-butyl-phthalate was detected in DW-61 at concentrations of 39 and 22 ug/l (duplicate sample).

D. Potential Disposal Area

The Potential Disposal Area was identified during an examination of aerial photographs from the 1950's and 1960's. This area exhibited signs of excavation activities, stressed vegetation, and discarded debris. The Potential Disposal Area lies in a wooded area approximately 200 feet west of the Main Plant Area. Based on the aerial photographs, the Potential Disposal Area is approximately 100 feet by 100 feet in size. The Potential Disposal Area lies between a residential development to the north and the gas pipeline right-of-way to the south. A small stream, which flows from the residential properties, bounds the Potential Disposal Area to the west. Small mounds of soil and concrete blocks were scattered throughout the area. Debris in the Potential Disposal Area included auto parts, an empty crushed drum, a barbed wire fence along the northern boundary, and miscellaneous trash. To determine the extent of the Potential Disposal Area, a geophysical grid for a magnetic survey was configured so that the boundaries of the grid extended past the obvious boundaries of the Potential Disposal Area. The geophysical grid in the Potential Disposal Area encompassed an area 160 feet wide (east-west) by 120 feet long (north-south). (See Figure 16)

A geophysical survey, soil gas survey, and subsurface boring program were conducted in the winter of 1995 through spring of 1996 to determine the nature and extent of contamination at the Potential Disposal Area.

The application of a magnetometer/gradiometer survey at the Potential Disposal Area indicates that a small amount of metal is strewn about the ground surface. Magnetic field and gradient anomalies were generally small in area and less than 100 gammas. Anomalies associated with a number of buried drums are usually greater than 200 gammas in strength. Nearly all significant magnetic field and gradient anomalies above 50 gammas and 5 gammas per foot respectively, were associated with some form of metal lying at the ground surface. These results suggest that drums were probably not buried at the Potential Disposal Area. Results of the magnetometer/gradiometer survey were consistent with results of the soil gas survey and soil boring program at the Potential Disposal Area.

Soil Gas Survey

Fourteen soil gas samples were collected in March 1996 at the Potential Disposal Area. Soil-gas collectors were placed in areas identified as suspect following the geophysical survey and several Site walk-overs. Additional devices were installed to provide adequate areal coverage. Soil gas samples were analyzed for eight TCE-related VOCs listed in Table 6. VOCs were not detected in the soil gas samples collected at the Potential Disposal Area.

Subsurface Soil

The subsurface at the Potential Disposal Area is defined by six soil borings (Figure 16). Soil borings were drilled to a maximum depth of 27 feet below ground surface. Bedrock was not encountered at the Potential Disposal Area in any of the soil borings. Overburden deposits at the Potential Disposal Area consist of reddish brown and whitish-gray silts and sands interbedded with clays, and clayey silts and sands. Gravel and pebble size limestone/dolomite clasts are found throughout the overburden deposits but occur in greater density in the 2 to 6 foot interval. Silt units beneath the Potential Disposal Area range in thickness from 1 foot (PDA-3) to 19 feet (PDA-5). Sand units range in thickness from 2 feet (PDA-4) to 25 feet (PDA-3) at the Potential Disposal Area.

Sixteen subsurface soil samples were collected for laboratory analysis from the 5 borings at the Potential Disposal Area. Samples were collected from three 2-foot intervals in each boring. Since organic vapors were not detected in the borings, the intervals sampled for laboratory analysis were chosen based on lithologic changes to achieve horizontal and vertical coverage, and to determine vertical extent of contamination, if any exists.

Volatile Organic Compounds

A low level of toluene was detected in one sample at the PDA-2 at 25-27 foot depth. VOCs detected but at concentrations not substantially above levels detected in laboratory blanks) include acetone, MEC, and total xylene. MEC was detected in all sixteen soil samples collected at the Potential Disposal Area ranging in concentrations from 7 to 21 ug/kg (all B flagged). SSLs were exceeded for MEC (10 ug/kg) in 15 subsurface soil samples, all of which were B flagged and associated with possible blank contamination.

Semivolatile Organic Compounds

A low concentration of diethyl phthalate was detected in one sample at the PDA-5, 25-27 feet. (42 ug/l). Other SVOCs detected in the samples but flagged with a B qualifier (concentrations not substantially above levels detected in laboratory blanks) included bis(2-ethylhexyl) phthalate (Figures 4-26 and 4-27). SSLs were not exceeded for SVOCs in the subsurface at the Potential Disposal Area.

Inorganics

Twenty metals and cyanide were detected in the subsurface at the Potential Disposal Area. Seventeen metals were detected in 10 or more of the samples collected in the subsurface at the Potential Disposal Area.

SSLs were exceeded for arsenic, barium, chromium, and selenium in the subsurface at the Potential Disposal Area. SSLs were exceeded for arsenic and barium in two samples with maximum concentrations of 16.2 mg/kg (PDA-1 at 6-8 feet) and 53.2 mg/kg (PDA-5 at 8-10 feet), respectively. SSLs were exceeded for chromium and selenium in one sample at concentrations of 22.1 mg/kg and 23.6 mg/kg (PDA-4 at 25-27 ft.) respectively. These metals were present at elevated levels in the background soil sample (FDA-2), and may therefore represent ambient soil conditions. With the exception of selenium, concentrations of all the metals lie within average range for background locations in the eastern United States.

E. Previous Investigation Data

Soil

Several soil gas surveys, soil sampling programs, and groundwater sampling events have been conducted at the Site. Two soil gas surveys were performed at the Site between 1989 and 1993. Soil gas surveys were performed at the Main Plant Area and Former Disposal Area/Mounded Area in December 1989, and a second soil gas survey was conducted in the mounded area of the Former Disposal Area/Mounded Area in October 1992.

Total VOC soil gas concentrations ranged from undetected to 530 ppm in the Former Disposal Area/Mounded Area. VOC concentrations were slightly lower farther from the Mounded Area, but most samples still showed discernible levels of contamination. Total VOC soil gas concentrations at the Main Plant Area ranged from 1.73 ppm to 1,035 ppm. The area southeast of the distillation building had the highest readings.

The soil gas surveys indicated the presence of VOC contamination of the soil. This data was not used quantitatively in the risk assessment due to the nature of the data, but was used to indicate areas of potential concern for inhalation exposure.

Several soil sampling programs have been conducted at the Main Plant Area and Former Disposal Area/Mounded Area since 1990. Soil borings were installed at the main plant to investigate contamination in soils below the former USTs, at the condensate disposal area (area southeast of the distillation building), and at the garage loading dock. Borings have also been installed around the excavations at the Former Disposal Area/Mounded Area created by the removal of drums and debris, and the Mounded Area. Surface soil samples have been collected from the Main Plant Area and the Former Disposal Area/Mounded Area.

Soil borings installed in the excavation area of the Former Disposal Area/Mounded Area in 1990

indicated the presence of VOCs (6 - 96 ug/kg total VOC). Soil borings installed in the Mounded Area in 1992 showed much higher levels of VOCs (up to 224,400 ug/kg total VOC). Constituents detected included 1,1,1-TCA, PCE, TCE, 1,1,2-TCA, 1,1-DCE, 1,2-DCA, and bromoform. Similar compounds and concentrations were detected in the soil borings sampled in 1996 from the Mounded Area. Additionally, low levels of PAHs were detected in the samples collected in 1996. Soil borings were not sampled from the Former Disposal Area excavation area in 1996. Surface soil samples were collected at the mounded area of the Former Disposal Area/Mounded Area in February 1991 and March 1996. VOCs were detected during both sampling events, and the concentrations in 1996 were lower than the 1991 concentrations.

Soil boring samples collected from the Main Plant Area in January 1990 and March 1996 indicated that the highest contamination was present in the area from which the USTs were removed. Surface soil samples were collected from the Main Plant Area in March 1996. VOCs were detected in many of the samples.

VII. SUMMARY OF SITE RISKS

Following the Remedial Investigation, analyses were conducted to estimate the human health and environmental hazards that could result if contamination at the Site is not cleaned up. These analyses are commonly referred to as risk assessments and identify existing and future risks that could occur if conditions at the Site do not change. The Baseline Human Health Risk Assessment (BLRA) evaluated human health risks and the Ecological Risk Assessment (ERA) evaluated environmental impacts from the Site.

A. Human Health Risks

The BLRA assesses the toxicity, or degree of hazard, posed by contaminants related to the Site, and involves describing the routes by which humans could come into contact with these substances. Separate calculations are made for those substances that are carcinogenic (cancer causing) and for those that are non-carcinogenic, but can cause other adverse health effects.

The primary objective of the risk assessment conducted was to assess the health risks to individuals who may have current and future exposure to contamination present at and migrating from the Site under existing site conditions. The risk assessment is comprised of the following components:

- *Identification of Chemicals of Potential Concern (COPCs)* - identify and characterize the distribution of COPCs found on-Site.
- *Exposure Assessment* - identify potential pathways of human exposure, and estimate the magnitude, frequency, and duration of these exposures.
- *Toxicity Assessment* - assess the potential adverse effects of the COPCs.
- *Risk Characterization* - characterize the potential health risks associated with exposure to site related contamination.

Each of these steps is explained further below.

1. Identification of COPCs

The identification of COPC includes data collection, data evaluation, and data screening steps. The data collection and evaluation steps involve gathering and reviewing the available site data and developing a set of data that is of acceptable quality for risk assessment. This data set is then further screened to reduce the data set to those chemicals and media of potential concern. The data used for the quantitative risk analysis were all validated prior to use in the risk assessment.

Soil

The only soil data that have been validated are the data collected during the RI conducted by EPA. Therefore, the 1996 soil sampling data were used for the quantitative risk assessment. Soil boring data collected from between 0-12 feet were used to evaluate subsurface exposure. Surface soil samples collected from 0-0.5 feet were used to evaluate surface soil exposure. Soil samples were analyzed for VOCs, SVOCs, metals, and cyanide.

The 1996 soil data were grouped into the six exposure areas previously discussed for the risk assessment. The areas include the soils at the Former Disposal Area/Mounded Area, the UST area, the aboveground storage tank area, the area southeast of the distillation building, and the area south of the garage at the main plant.

Groundwater

Groundwater data from August 1994 and May 1996 were used for the risk analyses. These were the only data collected at the Site that have been validated. In general, VOC concentrations appear to have remained the same or have slightly decreased over time. Therefore, use of the 1994 and 1996 groundwater data are representative of current Site conditions.

The three most contaminated wells within each plume were selected for the quantitative risk assessment. Wells CC-6, CC-7, and CC-13 were used to represent worst-case groundwater at the Main Plant Area, and wells CC-5, CC-15, and CC-16 were used to represent worst-case groundwater at the Former Disposal Area/Mounded Area.

Risks associated with use of the domestic wells were also evaluated. Data from wells without carbon filters were used to evaluate current residential risks and data collected prior to the filter (or after the filter if breakthrough was detected) for the wells equipped with carbon filters were used to evaluate potential future residential risks.

Background Samples

Five background surface soil samples and four background soil borings have been collected at the Site. Only two samples from the background soil borings are useable for the risk assessment due to the depth of the samples used to represent subsurface soil exposure.

Data from the Philadelphia Suburban Water Company (PSWC) Great Valley well was representative of background conditions in the aquifer beneath the Site. The inorganic data collected from the Great Valley well in October 1992, prior to the well becoming contaminated, was used as the background groundwater for the risk assessment.

Selection of Chemicals of Potential Concern

The COPC selection process was conservative, to ensure selection of the most constituents. Selection of COPCs was based on the criteria presented in EPA Region III guidelines. The maximum concentration of each detected constituent in each media was compared to the following criteria to select the COPCs per area. If the maximum concentration of a constituent exceeded each of the criteria, the constituent was selected as a COPC.

- *Comparison with Health-based Criteria:* The maximum detected chemical concentrations in groundwater and soil were compared with risk-based concentrations (RBCs) that were developed using current toxicity factors in the exposure formulas provided by EPA Region III. These screening level RBCs were based on a target hazard index of 0.1 and a target cancer risk of 1×10^{-6} . For soils, the cross-media protection criteria (for air) were developed using the EPA Soil Screening Guidance. Soil saturation concentrations were calculated and used as the screening value if they were less than the soil RBC. Constituents with maximum detected concentrations below the RBC or soil saturation values were eliminated from the COPC list.
- *Comparison with Background Samples:* The 95 percent upper tolerance limit (95% UTL) was calculated for each inorganic constituent detected in the set of background soil samples. For potential source areas where the maximum detected concentration was greater than the background 95% UTL (or the maximum background concentration if the 95% UTL is greater than the maximum), the inorganic constituent was retained as a COPC.
- *Comparison with Recommended Dietary Allowances (RDAs):* Chemicals which are human nutrients, present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and toxic only at very high doses were eliminated from the quantitative risk analysis. These constituents are calcium, magnesium, potassium, and sodium. All of the human nutrients detected in groundwater and soil, except for manganese in the Main Plant Area plume, result in intakes below RDAs. Ingestion of groundwater from the Main Plant Area plume by future adult residents would result in an intake of 300 mg/day, which slightly exceeds the RDA of 280 mg/day. This is not a significant exceedence, and manganese is not a significant contributor to the intake and resulting potential health effects.

Iron, which is also considered a human nutrient, was evaluated quantitatively in the risk assessment because there is a provisional toxicity value for iron. Ingestion of soil at the Former Disposal Area excavated area would result in an intake of 11.5 mg/day by a child which slightly exceeds the RDA for a child of 10 mg/day. Ingestion of groundwater from the Main Plant Area plume would result in an adult intake of 640 mg/day for an adult resident and an intake of 320 mg/day for a child resident, which both exceed the RDA of 15 mg/day and 10 mg/day for an adult and child, respectively.

Chemicals of Potential Concern

Table 7 identifies the chemicals that were selected as COPC based on the above screening methodology for each of the six potential source areas (soil) and the two groundwater plumes. There were no COPC present at the area south of the garage, therefore this area was not considered a potential source area and a quantitative risk evaluation was not carried out.

The domestic wells located off the Chemclene property were also screened using the above screening and data evaluation methods. The data were separated into two separate sets, domestic wells with filters and domestic wells without filters. All of the domestic wells that were sampled in 1995 and had at least one VOC detected were screened for COPC.

Although the ROD focuses on the chemical risk-drivers at the Site, other contaminants not specifically discussed in the ROD were also observed in environmental samples at noteworthy concentrations and are a concern to EPA. (A detailed evaluation of all chemicals exceeding risk screening criteria, i.e. - CoPCs, is presented in the Baseline Risk Assessment of the Remedial Investigation Report.)

2. Exposure Assessment

An exposure assessment involves three basic steps: 1) identifying the potentially exposed populations, both current and future; 2) determining the pathways by which these populations could be exposed; and 3) quantifying the exposure. Under current Site conditions, the BLRA identified potential populations as having the potential for exposure to Site-related contaminants, either currently and/or in the future. The migration pathways for the contamination from the source areas include: volatilization of the chlorinated solvents from soil, subsurface soil and groundwater, downward migration of the VOCs from soil to the groundwater, and lateral downgradient transport of VOCs in the groundwater.

Current Land Use

Chemclene currently sells hydraulic oil, industrial cleaning solvents, hydraulic fluid, and hydrogen peroxide, and operates a hauling operation from the Main Plant Area of the Site. Therefore, current populations which could be exposed include the employees and visitors of Chemclene Corporation. Chemclene uses a local on-Site well for process and wash water at the plant. This water is not used as a potable water supply. Chemclene uses water from domestic well DW-010 or bottled water as a potable water supply for site workers. The Main Plant Area and part of the Former Disposal Area/Mounded Area are not physically separated from the surrounding land and are accessible to the off-Site public under current conditions. Therefore, potentially exposed populations to the Main Plant and unfenced portions (mounded area) of the Former Disposal Area/Mounded Area include trespassers. Individuals currently using the Chemclene property may be exposed to contaminants in the surface soil.

Another population which currently could be exposed to Site contaminants is the residents that live hydraulically downgradient of the Chemclene property. Residents near the Chemclene property obtain their potable water from private groundwater wells. Twenty of the 51 residential wells in the vicinity of the plant have carbon filters to treat organic contamination. Data obtained from domestic well sampling indicate elevated levels of several organic constituents in

groundwater that are Site-related. These persons may be exposed to constituents in groundwater during potable use.

In summary, the populations potentially exposed and the possible pathways under current land use include:

1. Chemcene employees working outdoors potentially exposed through incidental ingestion, dermal contact, and inhalation of volatiles and fugitive dust from surface soils.
2. Trespassers playing on or walking across the Chemcene property potentially exposed through incidental ingestion, dermal contact, and inhalation of volatiles and fugitive dust from surface soils.
3. Residential groundwater users downgradient of Chemcene property potentially exposed through ingestion of and dermal contact with groundwater, and inhalation of volatiles from groundwater while showering or bathing.

Potential Future Uses

The predominant land use in East Whiteland Township is agriculture, rural residential, and open space. However, agriculture and open space areas are decreasing as the area is being converted to residential and commercial properties. The future land use for the Site and surrounding area is expected to be similar to the current land use, either commercial or residential. The Chemcene property is currently commercial, but could possibly be converted to a residential area in the future. This property could also be used by a different owner for commercial operations. This may entail expanding the number of workers, and may include using the groundwater as a potable water supply. Also, construction activities may take place at the Site.

In summary, the populations potentially exposed and the possible exposure pathways under future land use include:

1. Construction workers potentially exposed through incidental ingestion, dermal contact, and inhalation of volatiles and fugitive dust from surface and subsurface soils.
2. Trespassers playing on or walking across the Chemcene property potentially exposed through incidental ingestion, dermal contact, and inhalation of volatiles and fugitive dust from surface soils.
3. Residents living on the Chemcene property potentially exposed through incidental ingestion, dermal contact, and inhalation of volatiles and fugitive dust from surface soils, and ingestion of and dermal contact with groundwater, and inhalation of volatiles from groundwater while showering and bathing.
4. Residential groundwater users living downgradient of the Chemcene property potentially exposed through ingestion of and dermal contact with groundwater, and inhalation of volatiles from groundwater while showering and bathing.
5. Commercial and construction workers potentially exposed through ingestion of groundwater from beneath the Chemcene property.

In order to quantify the potential exposure associated with each pathway, assumptions must be made for various factors used in the calculations. Table 8 summarizes the values used in this

BLRA.

3. Toxicity Assessment

The purpose of the toxicity assessment is to weigh available evidence regarding the potential for particular contaminants to cause adverse effects in exposed individuals. Where possible, the assessment provides a quantitative estimate of the relationship between the extent of exposure to a contaminant and the increased likelihood and/or severity of adverse effects.

A toxicity assessment for contaminants found at a Superfund site is generally accomplished in two steps: 1) hazard identification; and 2) dose-response assessment. Hazard identification is the process of determining whether exposure to an agent can cause an increase in the incidence of a particular adverse health effect (e.g., cancer or birth defects) and whether the adverse health effect is likely to occur in humans. It involves characterizing the nature and strength of the evidence of causation.

Dose-response evaluation is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the administered population. From this quantitative dose-response relationship, toxicity values (e.g., reference doses and slope factors) are derived that can be used to estimate the incidence or potential for adverse effects as a function of human exposure to the agent. These toxicity values are used in the risk characterization step to estimate the likelihood of adverse effects occurring in humans at different exposure levels.

For the purpose of the risk assessment, contaminants were classified into two groups: potential carcinogens and noncarcinogens. The risks posed by these two types of compounds are assessed differently because noncarcinogens generally exhibit a threshold dose below which no adverse effects occur, while no such threshold can be proven to exist for carcinogens. As used here, the term carcinogen means any chemical for which there is sufficient evidence that exposure may result in continuing uncontrolled cell division (cancer) in humans and/or animals. Conversely, the term noncarcinogen means any chemical for which the carcinogenic evidence is negative or insufficient.

Slope factors have been developed by EPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic contaminants of concern. Slope factors, which are expressed in units of (mg/kg/day)⁻¹ are multiplied by the estimated intake of a potential carcinogen, in mg/kg/day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper-bound" reflects the conservative estimate of the risks calculated from the slope factor. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Slope factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied to account for the use of animal data to predict effects on humans. Slope factors used in the baseline risk assessment are presented in Table 10.

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to contaminants of concern exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg/day, are estimates of acceptable lifetime daily

exposure levels for humans, including sensitive individuals. Estimated intakes of chemicals from environmental media (e.g. the amount of a chemical ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors help ensure that the RfDs will not underestimate the potential for adverse noncarcinogenic effects to occur. Reference doses used in the baseline risk assessment are presented in Table 9.

4. *Human Health Effects*

Toxicological profiles of selected constituents, including carbon tetrachloride, 1,1-DCE, cis-1,2-DCE, PCE, 1,1,2-TCA, and TCE which are primary contaminants contributing to Site risks, can be found in Appendix A. In addition, a toxicity profile is provided for lead which does not have published toxicity values.

5. *Risk Characterization*

The risk characterization process integrates the toxicity and exposure assessments into a quantitative expression of risk. For carcinogens, the exposure point concentrations and exposure factors discussed earlier are mathematically combined to generate a chronic daily intake value that is averaged over a lifetime (i.e., 70 years). This intake value is then multiplied by the toxicity value for the contaminant (i.e., the slope factor) to generate the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the contaminant. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) established acceptable levels of carcinogenic risk for Superfund sites ranging from one excess cancer case per 10,000 people exposed to one excess cancer case per one million people exposed. This translates to a risk range of between one in 10,000 and one in one million additional cancer cases. Expressed as scientific notation, this risk range is between $1.0\text{E-}04$ and $1.0\text{E-}06$. Remedial action is warranted at a site when the calculated cancer risk level exceeds $1.0\text{E-}04$. However, since EPA's clean up goal is generally to reduce the risk to $1.0\text{E-}06$ or less, EPA also may take action where the risk is within the range between $1.0\text{E-}04$ and $1.0\text{E-}06$.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (i.e., the chronic daily intake) with the toxicity of the contaminant for a similar time period (i.e., the reference dose). The ratio of exposure to toxicity is called a hazard quotient. A Hazard Index (HI) is generated by adding the appropriate hazard quotients for contaminants to which a given population may reasonably be exposed. The NCP also states that sites should not pose a health threat due to a non-carcinogenic, but otherwise hazardous, chemical. If the HI exceeds one (1.0), there may be concern for the potential non-carcinogenic health effects associated with exposure to the chemicals. The HI identifies the potential for the most sensitive individuals to be adversely affected by the noncarcinogenic effects of chemicals. As a rule, the greater the value of the HI above 1.0, the greater the level of concern.

Table 9 summarizes the total-risk levels for current and future Residential Well Users. Table 10 summarizes the total risk levels from all appropriate exposure routes calculated for each group of individuals. Table 11 summarizes the total risk levels by each area (i.e. Former Disposal Area, Main Plant Area).

B. Ecological Risk Assessment

The ecological risk assessment was designed to evaluate the potential threats to ecological organisms from exposure to Site contaminants and to establish potential Site-specific clean-up level(s) for the contaminants of concern. Both acute (short-term) and chronic (long-term) studies were conducted for a variety of organisms, representing several different trophic levels. Direct toxicity usually results from direct exposure to certain metals and volatile compounds, and is best evaluated from laboratory or on-Site bioassays. Both chronic and acute bioassays were used to assess direct toxicity at this Site. Indirect or secondary toxicity usually results when birds and mammals accumulate contaminants (some metals, PCBs, and pesticides) in their bodies from eating contaminated prey. Therefore, chronic threats (long-term survival, growth and reproduction) to birds and mammals were assessed by conservatively estimating the amount of contaminated prey that may be consumed on-Site and comparing that dose to a known effect level. The following summarizes the various tools that were used to assess ecological risk at the Site:

- surface water bioassays with invertebrates and fish
- sediment bioassays with amphipods and midges
- soil bioassays with earthworms
- food chain modeling with birds and mammals.

The results indicate the following:

- Three potential wetland areas were identified between the Main Plant Area and the Former Disposal Area/Mounded Area.
- With the exception of one sampling location (W1), the results of a 7-day aqueous phase toxicity evaluation using the cladoceran *Ceriodaphnia dubia* suggest that there is no toxicity associated with surface water to freshwater invertebrates at the Site.
- The results of a 7-day aqueous-phase toxicity evaluation using the fish *Pimephales promelas* suggest that there is no toxicity associated with surface water to freshwater invertebrates at the Site.
- The results of a 10-day solid-phase toxicity evaluation using the crustacean (*Hyallela azteca*) and midge (*Chironomus tentans*) suggest that there is no acute or chronic toxicity associated with surface sediment to freshwater invertebrates at the Site.
- The results of the 14-day and 28-day solid-phase toxicity evaluation using *Eisenia foetida* suggest that there is no toxicity (acute or chronic) associated with the surface soil to soil-dwelling invertebrates at the Site.
- The results of the hazard quotient calculations for omnivorous and carnivorous mammals suggest that the levels of PCBs, aluminum, chromium, lead, manganese, and selenium in the surface soil, surface water, and soil invertebrate community at the Site are sufficient to pose a risk to the survival, growth, and/or reproduction of omnivorous and carnivorous mammals, all long-term effects anticipated if these organisms feed constantly onsite.

- The results of the risk characterization for omnivorous and carnivorous birds suggest that there is also a potential chronic risk associated with PCBs, aluminum, cadmium, lead, and zinc at the Site.

These results suggest that the levels of PCBs, aluminum, cadmium, lead, and zinc in the surface soil, surface water, and soil invertebrate community at the Site are sufficient to pose a risk to the survival, growth, and/or reproduction of omnivorous and carnivorous birds.

RECOMMENDATIONS

The weight of evidence approach was used to evaluate the results of the ecological risk assessment. Compounds were evaluated based on the mechanism of toxicity and the measurement endpoint which supported the evaluation related to the mechanism. Two approaches were evaluated, direct toxicity which include metals and volatiles, and food chain accumulation which include PCB, pesticides, and some metals.

The direct toxicity evaluations indicate that metals or volatiles do not pose a risk through direct toxicity.

PCBs were detected in surface soils at several locations within the Former Disposal Area/Mounded Area. Based on food chain evaluations, the levels observed in those areas pose a potential chronic ecological risk. Although metals pose a potential ecological risk, these are not Site-related and are representative of background conditions. However, the selected alternative will eliminate any potential ecological risk associated with exposure to soils contaminated with PCBs.

VIII. DESCRIPTION OF REMEDIAL ALTERNATIVES CONSIDERED FOR THE SITE

The Feasibility Study (FS) discusses a series of alternatives to address the subsurface soil and groundwater at the Main Plant Area and Former Disposal Area and groundwater contamination south of the Chemclene property. The FS and Addendum (May 29, 1997) also provide supporting information relating to the alternatives in this ROD.

Four to eight alternatives for each of the media at the two locations were identified as possible response actions. These are numbered to correspond with alternatives found in the FS. The alternatives will be discussed in the following sections: water supply alternatives for both areas, Main Plant Area soil and groundwater alternatives, and Former Disposal Area soil and groundwater alternatives. For a summary of alternatives, see Table 12.

WATER SUPPLY

Alternative WS-G-3a: Public Water Supply
Alternative WS-G-3b: Well Head Treatment

Alternative WS-G-3-a:	Public Water Supply
Capital Cost:	\$ 408,600
Operation and Maintenance:	\$ 97,371
Total:	\$ 505,971

The objective of this alternative is to prevent contact with contaminated groundwater at the residences affected or potentially affected by the Site. This objective can be accomplished by connecting residences affected and potentially affected by the Site to a public drinking water supply. Establishment of a permanent connection to a public water supply would eliminate the use of contaminated groundwater. Affected residential wells would be abandoned upon connection to a public water supply or converted to monitoring wells. By the end of 1997, Philadelphia Suburban Water Company plans to install water mains in Phoenixville Pike from Aston Road to Conestoga Road, and to extend the existing main in Conestoga Road north to Bacton Hill Road.

Because contaminated media would be left on the Site, a review of the Site conditions would be required every five years, as specified in the NCP.

Alternative WS-G-3b:	Well Head Treatment
Capital Cost:	\$ 113,676
Annual Operation and Maintenance:	\$ 42,000
Operation and Maintenance Period:	30 Years
Total Cost:	\$ 979,647

The objective of well head treatment would be to reduce the concentrations of VOC contaminants in residential drinking water to meet drinking water standards. Well head treatment would include the purchase, installation, maintenance, and monitoring of carbon filters at each of the affected residences.

Residences hydraulically downgradient of the Former Disposal Area/Mounded Area include homes in the Hillbrook Circle development and nearly all residences along Conestoga Road and Phoenixville Pike. Only one residence is hydraulically downgradient of the Main Plant Area (DW-10). Presently, 19 residences in Hillbrook Circle and on Phoenixville Pike are equipped with either single or double canister unit filters.

Under this alternative, contaminated media would be left on the Site and a review of the Site conditions would be required every 5 years.

MAIN PLANT AREA

Soil Alternatives

- MPA S-1: No Action
- MPA S-2: Institutional Controls
- MPA S-3: Capping
- MPA S-4: InSitu Soil Vapor Extraction

Alternative MPA-S-1:	No Action
Capital Cost:	\$0
Annual Operation and Maintenance:	\$0
Total Cost:	\$0

The NCP requires that EPA consider a "No Action" alternative for every Superfund site to establish a baseline or reference point against which each of the remedial action alternatives are compared. In the event that the other identified alternatives do not offer substantial benefits over this alternative, the No Action alternative may be considered a feasible approach.

Alternative MPA-S-2:	Institutional Controls
Capital Cost:	\$ 89,000
Annual Operation and Maintenance:	\$ 56,000
Operation and Maintenance Period:	30 Years
Total Cost:	\$ 1,145,000

The purpose of the institutional controls is to prohibit temporarily or permanently certain activities on parts of the Site that pose unacceptable risk. Institutional controls protect human health to some degree by diminishing the potential for exposure. Institutional controls would include deed restrictions to limit future use of the Site, fencing to restrict access, and Site reviews every five years.

Alternative MPA-S-3:	Capping
Capital Cost:	\$ 343,000
Operation and Maintenance:	\$ 30,000
Operation and Maintenance Period:	30 Years
Total Cost:	\$ 940,441

This alternative consists of installation of a cap over the Main Plant Area soils which have

concentrations of contaminants which are above the clean up standards established for the protection of groundwater. For purposes of the cost evaluation, the cap is assumed to be concrete and to extend around the existing buildings. This would reduce infiltration through contaminated soil and allow the facility to remain available for commercial use. This is practicable because the building floors provide a cap. In the event of disuse of the existing buildings, further evaluations of the soils beneath the buildings would be required to determine the need for extension of the cap. In addition, any existing equipment or tanks shall be removed in order to allow for the extension of the cap over affected areas. The actual size and locations of the capped areas would be determined during the remedial design phase of the project. Key elements of this alternative include Site grading, installation of a cap in the Main Plant Area, including stormwater controls, vapor monitoring points, and long-term monitoring.

Alternative MPA-S-4:	In-Situ Soil Vapor Extraction (SVE)
Capital Cost:	\$ 827,000
Annual Operation and Maintenance:	\$ 352,000
Operation and Maintenance Period:	5 Years
Total Cost:	\$ 2,351,000

The purpose of In-Situ SVE is to reduce the mass and concentration of VOC contaminants in the soil which are acting as a source of contamination to groundwater. The VOC contaminants would be removed from the Main Plant Area soils. Key elements of this alternative include installation of extraction wells (the depth and number of wells to be determined during remedial design), construction of a manifold, air treatment, disposal of the treatment wastes, and quarterly VOC monitoring. These factors, and the effectiveness of the technology for the area of concern would be evaluated by a pilot study. For purposes of the remedy at the Site, SVE would be combined with capping to enhance recovery efficiency.

Groundwater Alternatives

MPA-G-1:	No Action
MPA-G-2:	Institutional Controls
MPA-G-4:	Natural Attenuation
MPA-G-5:	Groundwater Collection, Treatment & Discharge
MPA-G-6:	Groundwater Collection, Treatment of Source Area & Discharge

Alternative MPA-G-1:	No Action
Capital Cost:	\$0
Annual Operation and Maintenance:	\$0
Total Cost:	\$0

Under this alternative, no further effort or resources would be expended. Consideration of this alternative is required, as stated previously. A review of Site conditions would be required every five years, since under this alternative, waste would be left in place.

Alternative MPA-G-2:	Institutional Controls
Capital Cost:	\$ 59,000
Annual Operation and Maintenance:	\$ 28,000
Operation and Maintenance Period:	30 Years

Total Cost: \$ 684,000

The purpose of institutional controls is to prevent the use of contaminated water-bearing units as a source of drinking water and/or to prevent the spread of contamination caused by groundwater pumping. Institutional controls protect human health to some degree by diminishing the potential for exposure. Key elements of this alternative include the legal requirements of the deed restrictions for groundwater use.

Alternative MPA-G-4:

Natural Attenuation

Capital Cost:	\$ 223,000
Annual Operation and Maintenance:	\$ 41,000
Operation and Maintenance Period:	30 Years
Total Cost:	\$ 986,116

Natural attenuation relies upon naturally occurring processes, particularly bioremediation, dilution, and dispersion to reduce concentrations of contaminants in the subsurface to below levels that pose little or no potential risk to human health and the environment. Under this alternative, groundwater samples are collected and analyzed for biological and chemical indicators to confirm contaminant biodegradation is reducing contaminant mass, mobility, and risk at an acceptable rate. Key elements of this alternative include construction of additional monitoring wells, monitoring for natural attenuation indicator parameters, preparation of trend analyses, and annual monitoring report preparation.

Alternative MPA-G-5:

Groundwater Collection, Treatment and Discharge

Capital Cost:	\$ 1,167,000
Annual Operation and Maintenance:	\$ 316,000
Operation and Maintenance Period:	30 Years
Total Cost:	\$ 6,213,637

This alternative reduces the mass and concentration of contaminants in groundwater to MCLs by pumping and treating of groundwater at selected wells. A principal effect will be to reduce the extent of the existing plumes. The overall pumping rate, and the number, depth, and location of wells were selected to minimize the overall costs of treatment. The objective of this groundwater extraction system would be to contain the contaminant plume by pumping the extraction wells to keep the contaminant plume from migrating further from the Main Plant Area.

To achieve discharge limits, extracted groundwater would be treated on-Site using air stripping followed by either vapor phase activated carbon or U/V oxidation. After treatment of groundwater, the effluent would be discharged by one or a combination of the methods below.

- direct discharge to Valley Creek
- on-Site spray irrigation of forested areas
- re-injection to subsurface
- trucking to a Publicly Owned Treatment Works (POTW)
- discharge to a water purveyor (including the costs of a main extension by the purveyor).

Groundwater reinjection and spray irrigation are the most likely discharge alternatives due to the Exceptional Quality designation of Valley Creek, the cost effectiveness of trucking discharge to a POTW, and the potential infeasibility of discharge to a water purveyor.

Alternative MPA-G-6: Groundwater Collection, Treatment of Source Area, and Discharge

Capital Cost:	\$ 1,233,000
Annual Operation and Maintenance:	\$ 316,000
Operation and Maintenance Period:	30 Years
Total Cost:	\$ 6,280,000

This alternative reduces mass and concentration of contaminants, similar to Alternative MPA-G-5; MPA-G-6 differs in the location of selected wells for groundwater withdrawal. This alternative requires pumping at the locations where Dense Non-Aqueous Phase Liquids (DNAPLs) are suspected. The strategy would be to collect contaminants in the dissolved phase along with any DNAPLs that are encountered. This pumping configuration would restore the groundwater to beneficial use. Groundwater treatment and discharge alternatives are the same as MPA-G-5 above.

FORMER DISPOSAL AREA/MOUNDED AREA

Soil Alternatives

FDA-S-1:	No Action
FDA-S-2:	Institutional Controls
FDA-S-3:	Capping
FDA-S-4:	Excavation, Off-Site Thermal Treatment, Disposal at a Subtitle C Landfill
FDA-S-5:	Excavation, ExSitu Volatilization, & Reuse as Backfill
FDA-S-6:	Excavation, On-Site Thermal Treatment, and Reuse as Backfill
FDA-S-7:	InSitu Soil Vapor Extraction
FDA-S-8:	Excavation, Consolidation of Soils at the Main Plant

Alternative FDA-S-1:	No Action
Capital Cost:	\$0
Annual Operation and Maintenance:	\$0
Total Cost:	\$0

Under this alternative, as stated previously, no further effort or resources would be expended.

Alternative FDA-S-2:	Institutional Controls
Capital Cost:	\$ 94,000
Annual Operation and Maintenance:	\$ 56,000
Operation and Maintenance Period:	30 Years

Total Cost: \$ 1,150,000

The purpose of institutional controls is to prohibit temporarily or permanently certain activities on parts of the Site that contain hazardous materials. Institutional controls protect human health to some degree by diminishing the potential for exposure. Institutional Controls would include deed restrictions to limit future use of the Former Disposal Area and fencing to restrict access. Key elements of this alternative include the location and costs of the fencing and the legal requirements of the deed restrictions.

Alternative FDA-S-3:

Capping

Capital Cost:	\$ 434,000
Annual Operation and Maintenance:	\$ 30,000
Operation and Maintenance Period:	30 Years
Total Cost:	\$ 974,285

The purpose of capping is to reduce potential leaching of contaminants in the unsaturated soil. This objective is accomplished by minimizing infiltration of rainfall and associated leaching of contaminants which are localized in the unsaturated soil zone. A gradual reduction in mass and concentration of contaminants in soil may occur as a result of natural attenuation processes. A cap can also be used to prevent exposure via direct contact with contaminated soils. Key elements of this alternative include grading, import of off-Site borrow material, installation of a clay, linear low density polyethylene membrane or bituminous concrete cap in the Former Disposal Area/Mounded Area, stormwater controls, soil vapor monitoring points and long-term monitoring.

Common Components for Alternatives FDA-S-4, FDA-S-5, FDA-S-6, and FDA-S-8

A common component for the excavation alternatives includes geoprobe exploration to more closely delineate volumes of soil which exceed clean up requirements, followed by excavation. Excavations will be above the water table and clean fill will be used to regrade the area. The principal factor for this alternative is the volume of material to be excavated. The volume of the excavated material was determined by the areal extent and depth of soils with contaminant concentrations which exceeded the clean up standards established for soil.

Alternative FDA-S-4:

Excavation, Off-Site Thermal Treatment, Disposal at Hazardous Waste Landfill

Capital Cost:	\$ 7,016,000
Annual Operation & Maintenance:	\$0
Total Cost:	\$ 7,016,000

The objective of excavation is to remove the mass of VOC contaminants in the vadose zone. Key elements of this alternative include geoprobe exploration, excavation and off-Site disposal to a hazardous waste landfill, backfilling, regrading, and land stabilization.

Alternative FDA-S-5: Excavation, Ex-Situ Volatilization, and Re-Use as Backfill

Capital Cost:	\$ 2,351,000
Annual Operation and Maintenance:	\$ 390,000
Operation and Maintenance Period:	1 Year
Total Cost:	\$ 2,787,000

The objective of excavation is to remove the mass of VOC contaminants in the vadose zone. Key elements of this alternative include geoprobe exploration, excavation, ex-situ volatilization, re-use of treated soils as backfill, regrading, and land stabilization. Because the soils contain RCRA listed hazardous waste, once treated, soils must meet certain levels in order to place the soil back onto the ground. EPA has a "Contained-In Policy" which allows that soils contaminated with RCRA hazardous waste can be treated to certain site-specific levels that would allow such soils to be placed back onto the ground. A future pilot study would be required to determine if ex-situ volatilization can treat soils to these site-specific levels that render the soil non-hazardous and allow backfilling.

Alternative FDA-S-6: Excavation, On-Site Thermal Treatment, and Re-Use as Backfill

Capital Cost:	\$ 3,858,000
Annual Operation and Maintenance:	\$0
Operation and Maintenance Period:	< 1 Year
Total Cost:	\$ 3,858,000

The objective of excavation is to remove the mass of VOC contaminants in the vadose zone. Key elements of this alternative include geoprobe exploration, excavation, on-Site thermal desorption, re-use of treated soils as backfill, regrading, and land stabilization. Because the soils contain RCRA listed hazardous waste, once treated, soils must meet certain levels in order to place the soil back onto the ground. EPA has a "Contained-In Policy" which allows that soils contaminated with RCRA hazardous waste can be treated to certain site-specific levels that would allow such soils to be placed back onto the ground. A future pilot study would be required to determine if on-Site thermal treatment can treat soils to these site-specific levels that render the soil non-hazardous and allow backfilling.

Alternative FDA-S-7: In-Situ Soil Vapor Extraction

Capital Cost:	\$ 1,308,000
Annual Operation and Maintenance:	\$ 581,560
Operation and Maintenance Period:	5 Years
Total Cost:	\$ 3,873,503

The objective of in-situ SVE is to reduce the mass and concentration of VOC contaminants in the vadose zone. SVE will greatly accelerate the rate at which the clean up levels can be attained. VOC contaminants will be removed from the subsurface soils. Key elements of this alternative include installation of extraction wells (the depth and number of wells will be determined during remedial design), air treatment, disposal of the treatment wastes, and quarterly VOC monitoring. The factors considered in sizing the treatment unit are the air conductivity of soil, mass of contaminants, and the concentration of VOCs recoverable in air. These factors were estimated for the FS. These factors would be evaluated by a future pilot study.

**Alternative FDA-S-8: Excavation with Consolidation at the Main Plant Area
Corrective Action Management Unit (CAMU)**

	Option 1		Option 2
Capital Cost:	\$ 684,319	Capital Cost:	\$ 777,762
Annual O&M:	\$ 30,000	Annual O&M:	\$ 30,000
O&M Period:	30 Years	O&M Period:	30 Years
Total Cost:	\$ 1,242,924	Total Cost:	\$ 1,336,367

The objective of this alternative is to remove contaminated soils from the Former Disposal Area/Mounded Area. The estimated 5,700 cubic yards of soil would be transported to the Main Plant Area and covered with a RCRA cap. Key elements of this alternative include geoprobe exploration, excavation and removal of contaminated soil to the Main Plant Area, removal of the collapsed quonset hut storage building, relocation of the office trailer, consolidation of soil and capping. In-situ treatment of contaminated soils by vapor extraction at the Main Plant Area was evaluated under Alternative MPA-S4 (In-Situ SVE). If Alternatives MPA-S-4 and FDA S-8 are both selected and pre-design pilot studies are favorable, the design of the In-Situ SVE system would be configured to treat soils transferred from the Former Disposal Area/Mounded Area to the Main Plant Area in addition to contaminated subsurface soils beneath source areas at the Main Plant Area.

Two options were evaluated for constructing a fill containing 5,700 cubic yards of contaminated soil. Option 1 involves razing and/or relocating several auxiliary structures at the Main Plant Area which are believed not to impact the current operation at the facility, including a former storage building which has collapsed in place, miscellaneous tanks and an office trailer. The completed fill would occupy approximately 0.43 acres and would have a maximum height of 20 feet with maximum side slopes of 2.5 to 1. This area would be capped separately from the proposed area in MPA-S3. Option 2 would require the razing of all existing structures at the Main Plant Area. Because Option 2 provides more surface area, the completed fill would occupy 0.8 acres and would rise a maximum of 7 feet above existing grade. The maximum side slopes for Option 2 would be 4:1. If Option 2 were selected, the surface area of the cap would include the majority of the Main Plant Area and therefore the cap included under MPA-S3 would not be required and would result in a significant cost savings.

For both Options 1 and 2, the northern boundary of the capped fill lies over 30 feet inside the northern property line. Locating the fill in this manner will accommodate keeping the easement open between the Former Disposal Area/Mounded Area and Main Plant Area, and should prevent problems regarding access and easements if the property is ultimately sold. However, the exact area of the cap would be finalized during remedial design.

The concept of the RCRA Corrective Action Management Unit (CAMU) is a critical element to this alternative. The federal CAMU regulation, which was effective in April 1993, can be applicable to CERCLA sites. A CAMU is an area within a facility that is designated by the EPA Regional Administrator under 40 C.F.R. Part 264 subpart S, for the purposes of implementing corrective action. A CAMU shall only be used for the management of remediation waste.

In this alternative, a CAMU would be used to consolidate contaminated soil from the Former Disposal Area into a single area at the Main Plant Area. This action would enlarge the surface

area affected by contaminated soil at the Main Plant Area but would have no impact on the groundwater clean up at the Main Plant Area. However, contaminated soil and remediation wastes would be effectively removed from the Former Disposal Area/Mounded Area which would reduce the timeframe for groundwater clean up at the Former Disposal Area. To comply with closure requirements, the relocated material would be covered with a RCRA cap.

Groundwater Alternatives

FDA-G-1:	No Action
FDA-G-2:	Institutional Controls
FDA-G-4:	Natural Attenuation
FDA-G-5:	Groundwater Collection, Treatment, and Discharge
FDA-G-6:	Groundwater Collection, Treatment (Single Well), and Discharge

Alternative FDA-G-1:	No Action
Capital Cost:	\$0
Annual Operation and Maintenance:	\$0
Total Cost:	\$0

Under this alternative, as stated previously, no further effort or resources would be expended on the groundwater at the Former Disposal Area.

Alternative FDA-G-2:	Institutional Controls
Capital Cost:	\$ 59,000
Annual Operation and Maintenance:	\$ 28,000
Operation and Maintenance Period:	30 Years
Total Cost:	\$ 684,000

The purpose of institutional controls is to prevent the use of contaminated water-bearing units as a source of drinking water or to prevent the spread of contamination caused by groundwater pumping through administrative means. Institutional controls protect human health to some degree by diminishing the potential for exposure. Key elements of this alternative include the legal requirements of the deed restrictions for groundwater.

Alternative FDA-G-4:	Natural Attenuation
Capital Cost:	\$ 227,000
Annual Operation and Maintenance:	\$ 42,000
Operation and Maintenance Period:	30 Years
Total Cost:	\$ 979,647

Contaminants are presently migrating within a groundwater plume toward Hillbrook Circle, located southwest of the Former Disposal Area/Mounded Area. A review of historical data indicates the area occupied by this plume has been at a steady-state or receding since drummed waste and contaminated soil were removed in the early 1980s (See Section II. Site History). Groundwater sampling and analysis has suggested that the contaminant plume was receding over this time period due to the drum and soil removal activities.

A receding contaminant plume occurs, in the absence of active remediation, when the rate of natural attenuation of contamination exceeds the rate at which contaminants enter the groundwater from a source. Typically, under receding conditions, the contaminant plume has expanded to a maximum extent and then the leading edge recedes as natural attenuation occurs along the periphery of the plume. The conditions at the Former Disposal Area/Mounded Area would suggest that the contaminant plume is approaching equilibrium with residual contamination which remains in the soil. The RI determined that there is significant evidence of biological and abiotic attenuation. Abiotic attenuation includes volatilization, sorption, hydrolysis, and dehalogenation. The solvents disposed at the Former Disposal Area/Mounded Area were primarily TCE, TCA, PCE, and MEC. However, other chlorinated species, including (cis)1,2-DCE, 1,1-DCE, and 1,1-DCA are present in approximately equal concentrations. These de-halogenated compounds are known to be degradation by-products of the more highly halogenated solvents which were disposed. Their presence in high concentrations indicates that the process of chemical degradation is advanced at the Former Disposal Area/Mounded Area. Under this alternative, groundwater samples are collected and analyzed for biological and chemical indicators to confirm contaminant biodegradation is reducing contaminant mass, mobility, and risk at an acceptable rate. Key elements of this alternative include construction of additional monitoring wells, quarterly monitoring for natural attenuation indicator parameters, preparation of trend analyses, and annual monitoring report preparation.

Alternative FDA-G-5:	Groundwater Collection, Treatment and Discharge
Capital Cost:	\$ 2,869,000
Operation and Maintenance:	\$ 2,898,000
Operation and Maintenance Period:	2 years
Total Cost:	\$ 8,258,000

This alternative includes the collection, on-Site treatment, and discharge of contaminated groundwater at the Former Disposal Area/Mounded Area. Because of the large area of the plume (extending from the Former Disposal Area to the residential area), and the high transmissivity of the aquifer, selecting a well configuration to capture the complete plume would be difficult. Different scenarios were modeled, but recovery well locations that would de-water the residential wells were rejected. Modeling indicated that a pumping rate of 2,000 gallons per minute from the four extraction wells along the property boundary would prevent migration of the majority (approximately 80%) of the plume. Though some of the plume on the property and in the Hillbrook Circle would not be captured, the outlying plume area would be reduced by natural attenuation, especially when isolated from the source of higher levels of contamination. The existing wells are not capable of this yield and actual implementation of this alternative would require installation of larger diameter extraction wells.

Several methods of disposal of treated water, as discussed in Alternative MPA-G-5, were considered. Re-injection was considered most plausible, however, reinjection down gradient of the property could cause contamination to migrate to previously uncontaminated areas and residences in Hillbrook Circle. Injection into eight wells upgradient of the extraction wells was determined to be more effective. This disposal method would help flush contaminants around monitoring well CC-14 toward the extraction wells. Extracted groundwater would be treated using air stripping combined with either activated carbon or U/V oxidation before re-injection. Clean up to MCLs is estimated to require two years.

Alternative FDA-G-6: Groundwater Collection (Single Well), Treatment, and Discharge

Capital Cost:	\$ 1,599,000
Annual Operation and Maintenance:	\$ 846,000
Operation and Maintenance Period:	7 Years
Total Cost:	\$ 3,269,802

This alternative includes the collection, on-Site treatment, and discharge of contaminated groundwater at the Former Disposal Area/Mounded Area. Alternative FDA-G-6 also relies on natural attenuation mechanisms to ultimately reduce groundwater contaminant concentrations below MCLs (5 ug/l for TCE). The intention of this alternative is to significantly reduce concentrations within the most highly contaminated portion of the plume. The pumping well would be shut off after two years and the plume would degrade to the MCL through natural attenuation.

In this alternative, contaminated groundwater would be intercepted at a single extraction well located downgradient of the Former Disposal Area/Mounded Area pumping at 500 gallons per minute. The exact location for the extraction well would be determined during design. Two wells could potentially be used if deemed necessary. Treated groundwater would be disposed by injecting groundwater in two injection wells located hydraulically upgradient of the Former Disposal Area/Mounded Area.

Results of the modeling indicated that concentrations in the central portion of the contaminant plume would decrease from greater than 1,000 ug/l to around 100 ug/l after two years of pumping. Concentrations in the central portion of the plume are estimated to reach the clean up level of 5 ug/l (MCL for TCE) in seven years.

Extracted groundwater would be treated at the plant with identical treatment and discharge processes as discussed for the Main Plant Area. The volume requiring treatment is estimated at 720,000 gallons/day.

IX. COMPARATIVE EVALUATION OF ALTERNATIVES

Each of the remedial alternatives summarized in this ROD has been evaluated against the nine (9) evaluation criteria set forth in the NCP, 40 C.F.R. Section 300.430(e)(9). These nine criteria can be categorized into three groups: threshold criteria, primary balancing criteria, and modifying criteria. A description of the evaluation criteria is presented below:

Threshold Criteria:

1. *Overall Protection of Human Health and the Environment* addresses whether a remedy provides adequate protection and describes how risks are eliminated, reduced, or controlled.
2. *Compliance with ARARs* addresses whether a remedy will meet all of the applicable, or relevant and appropriate requirements of environmental statutes. Preliminary ARARs each alternative are referenced in Appendix A1-A3 of the FS. ARARs for the Selected Remedy are summarized in Table 14.

Primary Balancing Criteria:

3. *Long-term Effectiveness* refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once clean up goals are achieved.
4. *Reduction of Toxicity, Mobility, or Volume through Treatment* addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume of contaminants.
5. *Short-term Effectiveness* addresses the period of time needed to achieve protection and any adverse impacts on human health and environment that may be posed during the construction and implementation period until clean up requirements are achieved.
6. *Implementability* addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.
7. *Cost* includes estimated capital, operation and maintenance costs, and present worth costs.

Modifying Criteria:

8. *State Acceptance* indicates whether, based on its review of backup documents and the Proposed Plan, the State concurs with, opposes, or has no comment on the preferred alternative.
9. *Community Acceptance* includes assessments of issues and concerns the public may have regarding each alternative based on a review of public comments received on the Administrative Record and the Proposed Plan.

Below is a summary of alternatives for reference during the comparative analysis:

Water Supply

- WS-G-3a: Public Water Supply
- WS-G-3b: Well Head Treatment

Main Plant Area Soils

- MPA S-1: No Action
- MPA S-2: Institutional Controls
- MPA S-3: Capping
- MPA S-4: InSitu Soil Vapor Extraction

Main Plant Area Groundwater

- MPA-G-1: No Action
- MPA-G-2: Institutional Controls
- MPA-G-4: Natural Attenuation
- MPA-G-5: Groundwater Collection, Treatment & Discharge
- MPA-G-6: Groundwater Collection, Treatment of Source Area & Discharge

Former Disposal Area Soils

- FDA-S-1: No Action
- FDA-S-2: Institutional Controls
- FDA-S-3: Capping
- FDA-S-4: Excavation, Off-Site Thermal Treatment, Disposal at a Subtitle C Landfill
- FDA-S-5: Excavation, ExSitu Volatilization, & Reuse as Backfill
- FDA-S-6: Excavation, On-Site Thermal Treatment, and Reuse as Backfill
- FDA-S-7: InSitu Soil Vapor Extraction
- FDA-S-8: Excavation, Consolidation of Soils at the Main Plant

Former Disposal Area Groundwater

- FDA-G-1: No Action
- FDA-G-2: Institutional Controls
- FDA-G-4: Natural Attenuation
- FDA-G-5: Groundwater Collection, Treatment, and Discharge
- FDA-G-6: Groundwater Collection, Treatment (Single Well), and Discharge

Water Supply Alternatives

1. Overall Protection of Human Health and the Environment

Implementation of Alternatives WS-G-3a or WS-G-3b identified above would not protect human health or the environment at the Main Plant Area or the Former Disposal Area/Mounded Area (i.e., the source areas) because they do not address groundwater contamination on the property. The risk posed from contaminated soil and potential exposure to contaminated groundwater on these areas would not be reduced. Migration of contamination would continue through soil-contaminant leaching, groundwater migration, surface water migration, and infiltration. Residual risks for these areas are identical to those identified in the baseline risk assessment.

Implementation of WS-G-3a or WS-G-3b would protect human health at the residences by eliminating the potential for direct contact with contaminated groundwater by ingestion. Residential water would be treated to drinking water standards under WS-G-3b or supplied from a public water supply under WS-G-3a.

2. Compliance with ARARs

Requirements for the use of groundwater as a residential water supply include meeting Safe Drinking Water Act MCLs. For carcinogens, these requirements include treating groundwater at least to concentrations that do not cause a lifetime cancer risk greater than 1 in 10,000. For systemic toxicants, these requirements include treating groundwater to media specific levels where people could be exposed by direct ingestion or inhalation on a daily basis with no appreciable risk of deleterious effects.

Chemical-specific ARARs for this WS-G-3a or WS-G-3b would be met at the residences, but would not be met at the source areas.

The location-specific ARAR which applies to WS-G-3a or WS-G-3b is the Delaware River Basin Commission requirement which prohibits adverse impacts to the groundwater resources in the Delaware River Basin. This ARAR would be met at the residences, but not at the source areas.

There are no action-specific ARARS which apply to WS-G-3a or WS-G-3b.

3. Long-Term Effectiveness and Permanence

Neither WS-G-3a or WS-G-3b provides long-term effectiveness and permanence within the source areas. The risk currently associated with the source areas would not be decreased and might be increased through migration of contaminants. Long-term risks posed by the source areas are described in the baseline risk assessment. Because of contaminants left at the Site, a review of Site conditions would be required every 5 years.

Alternative WS-G-3a and WS-G-3b would be effective in the long-term at protecting public health at the point of exposure. For well head treatment, maintenance and monitoring of carbon units would be necessary for the duration of well head treatment. However, connecting local residences to a water supply would provide long-term protection to public health at the point of

exposure and would require the O&M to ensure long term effectiveness.

4. Reduction of Toxicity, Mobility, and Volume through Treatment

Neither WS-G-3a or WS-G-3b would provide any reduction of toxicity, mobility, and volume of contaminants at the source areas and would not meet the statutory preference for treatment. WS-G-3a and WS-G-3b would provide a reduction of toxicity and volume of contaminants at the residential water supplies. WS-G-3b would meet the statutory preference for treatment at the residences.

5. Short-Term Effectiveness

No increased risk to the surrounding community would be realized by implementation of either WS-G-3a or WS-G-3B at the source areas. This alternative would be effective immediately at the residences upon installation of the carbon units or water supply.

6. Implementability

WS-G-3a and WS-G-3b are both easily implementable. Equipment and services to install, monitor, and maintain the carbon units are available from local sources. Installation of a water main is already planned by the Philadelphia Suburban Water Company and is a standard construction activity. However, the implementability of these alternatives that require Institutional Controls may be affected due to legal considerations.

7. Cost

Evaluation of costs of each alternative generally includes the calculation of direct and indirect capital costs and the annual O&M costs, both calculated on a present worth basis.

Direct capital costs include costs of construction, equipment, building and services, and waste disposal. Indirect capital costs include engineering expenses, start-up and shutdown, and contingency allowances. Annual O&M costs include labor and material; chemicals, energy, and fuel; administrative costs and purchased services; monitoring costs; cost for periodic Site review (every five years); and insurance, taxes, and license costs.

The total present worth costs of WS-G-3a is estimated at \$586,249 which is less expensive than WS-G-3b which is estimated at \$979,647.

8. State Acceptance

The Commonwealth of Pennsylvania has had the opportunity to review and comment on all the documents in the Administrative Record and has participated in selecting the remedy for this Site. The Commonwealth has had the opportunity to comment on the draft ROD and, to the extent possible, the Commonwealth's comments have been incorporated into the ROD.

9. Community Acceptance

A public meeting on the Proposed Plan was held on July 16, 1997 at the Great Valley High School, East Whiteland Township, Pennsylvania. Comments received orally at the public meeting and in writing during the comment period were in favor of the provision of a public water supply for affected residents. Oral and written comments on the remedial alternatives evaluated by EPA for the implementation at the Site are included in Part III of this ROD.

Main Plant Area - Soil Alternatives

1. Overall Protection of Human Health and the Environment

Alternative MPA-S-3, Capping, and Alternative MPA-S-4, In-Situ Soil Vapor Extraction (SVE) in combination, potentially achieve overall protection of human health and the environment. In the case of In-Situ SVE, effectiveness needs to be demonstrated through a treatability study. Alternative MPA-S-1, No Action, and Alternative MPA-S-2, Institutional Controls, would not be protective since clean up standards would not be met. Therefore, MPA-S-1 and MPA-S-2 will not be discussed further in this analysis since they do not meet this threshold criterion.

Alternative MPA-S-3, Capping, is the only alternative which would provide an immediate benefit by minimizing the release of contamination to groundwater from the contaminated soils in the unsaturated zone and protecting construction workers from direct contact with contaminated soils. The capping alternative also benefits In-Situ SVE, and several groundwater alternatives such as natural attenuation, conventional groundwater extraction, and DNAPL collection/groundwater extraction.

Alternative MPA-S-4, In-Situ SVE in combination with MPA-S-3, Capping, provides the largest reduction in soil migration and health-based risk on the Site through treatment of contamination above the clean up standards. The mass of contaminants in the soils would be reduced thereby and eliminate an ongoing source of contamination to groundwater.

2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARS)

Alternative MPA-S-3, Capping, and Alternative MPA-S-4, In-Situ SVE, would comply with chemical-, location-, and action-specific ARARs. A treatability study would be required for SVE to ensure that it can adequately achieve target clean up levels.

3. Long Term Effectiveness and Permanence

Alternative MPA-S-4, In-Situ SVE in combination with MPA-S-3, Capping, would be the most effective in the long-term since it incorporates treatment of the soil, which is not a reversible process and does not require long-term maintenance. A treatability study would be required.

Alternative MPA-S-3, Capping, would be effective in the long-term providing the O&M program and Institutional Controls are carried out. If the integrity of the cap is compromised, the contaminants in the underlying soil would be reactivated as a source of groundwater contamination and could lead to future exposures above the health-based risk standards.

4. Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative MPA-S-4, In-Situ SVE in combination with MPA-S-3, Capping, provides the most significant reduction in toxicity, mobility, and volume in the source areas. Alternative MPA-S-3, Capping, provides a reduction in mobility, but does not provide a reduction in toxicity and volume on-Site.

5. Implementability

This evaluation criterion addresses the difficulties and unknowns associated with implementing the clean up technologies associated with each alternative, including the availability of services and materials, and the reliability and effectiveness of monitoring. However, the implementability of any alternative that requires Institutional Controls may be affected due to legal considerations

Alternatives MPA-S-3 and MPA-S-4 are technically implementable. Alternative MPA-S-3, Capping, incorporates standard construction practices, including grading and paving for the concrete cap. An O&M program required for the cap incorporates standard construction practices. Alternative MPA-S-4, In-Situ SVE, incorporates standard construction practices. Routine O&M would include monthly sampling of extracted vapor and periodic changing of granular activated carbon for off-gas treatment.

Five year reviews would be required for Alternative MPA-S-3, Capping, since contaminated soils will remain on the Site. Five year reviews would be required for Alternative MPA-S-4, In-Situ SVE, during operation of the system.

6. Short-Term Effectiveness

A temporary increase in fugitive dust and construction traffic on nearby roads would occur during installation of the cap under Alternative MPA-S-3, Capping. Construction workers would be required to use personal protective equipment.

Alternative MPA-S-4, In-Situ SVE, would result in a temporary increase in fugitive emissions during construction and from treatment system operation. Off-gas from the treatment system would possibly require treatment. Construction workers would be required to use personal protective equipment.

7. Cost

MPA-S-3 Capping, costs \$940,441 and is less expensive than MPA-S-4, In-Situ SVE, at \$2,351,189.

8. State Acceptance

The Commonwealth of Pennsylvania has had the opportunity to review and comment on all the documents in the Administrative Record and has participated in selecting the remedy for this Site. The Commonwealth has had the opportunity to comment on the draft ROD and, to the

extent possible, the Commonwealth's comments have been incorporated into the ROD.

9. Community Acceptance

A public meeting on the Proposed Plan was held on July 16, 1997 at the Great Valley High School, East Whiteland Township, Pennsylvania. Comments received orally at the public meeting and in writing during the comment period were generally in favor of installation of a cap over the Main Plant Area. Comments were varied with respect to the implementation of SVE at the Main Plant Area. See Part III of this ROD for oral and written comments on the remedial alternatives evaluated by EPA for the implementation at the Site.

Main Plant Area - Groundwater Alternatives

1. Protection of Human Health and Environment

Neither Alternative MPA-G-1, No Action, nor Alternative MPA-G-2, Institutional Controls, alone would provide overall protection of human health and the environment and will, therefore, not be discussed further in this analysis. Alternative MPA-G-2, Institutional Controls, may be a viable method to enhance the effectiveness of other alternatives. Alternative MPA-G-4, Natural Attenuation, may be effective in preventing the downgradient extension of the plume of contaminated groundwater. However, the data also indicates that the release of contaminants to groundwater is an on-going process at the Main Plant Area. Without other measures to control the sources of contamination, the plume is expected to persist for an extended period of time. Due to the apparent strength of the contaminant sources at the Main Plant Area, Alternative MPA-G-4, Natural Attenuation, cannot be relied upon to achieve MCLs and will, therefore, not be discussed further in this analysis.

Alternatives MPA-G-5 and G-6 are expected to achieve overall protection of human health and the environment.

2. Compliance with ARARs

Alternative MPA-G-5, Groundwater Collection, Treatment, and Discharge, and Alternative MPA-G-6, Groundwater Collection, Treatment of Source Area, & Discharge, would comply with chemical-, location-, and action-specific ARARs.

3. Long-Term Effectiveness and Permanence

Both Alternatives MPA-G-5 and MPA-G-6 would be the most effective in the long-term since they incorporate treatment of the groundwater, which is not a reversible process.

4. Reduction of Toxicity, Mobility, and Volume through Treatment

Both alternative MPA-G-5 and MPA-G-6 provide the most significant reduction in toxicity, mobility, and volume at the source areas on the Chemclene property.

5. Short-Term Effectiveness

A temporary increase in fugitive dust and construction traffic on nearby roads would occur during installation of the groundwater treatment system under Alternatives MPA-G-5 and MPA-G-6. Construction workers would be required to use personal protective equipment. A temporary increase in fugitive emissions during treatment system operation would occur. Off-gas from the treatment system may require treatment.

6. Implementability

Alternatives MPA-G-5 and MPA-G-6 incorporate standard construction practices and equipment is readily available. However, the implementability of any alternative that requires Institutional Controls may be affected due to legal considerations.

Five year reviews would be required for Alternatives MPA-G-5 and MPA-G-6 during operation of the systems.

7. Cost

Of MPA-G-5 and MPA-G-6, G-5 is slightly less costly (\$ 6,213,515) than G-6 (\$6,279,515).

8. State Acceptance

The Commonwealth of Pennsylvania has had the opportunity to review and comment on all the documents in the Administrative Record and has participated in selecting the remedy for this Site. The Commonwealth has had the opportunity to comment on the draft ROD and, to the extent possible, the Commonwealth's comments have been incorporated into the ROD.

9. Community Acceptance

A public meeting on the Proposed Plan was held on July 16, 1997 at the Great Valley High School, East Whiteland Township, Pennsylvania. Comments received orally at the public meeting and in writing during the comment period were varied with respect to the installation of a Pump and Treat System at the Main Plant. See Part III, Section II of the Responsiveness Summary for detailed written comments and EPA responses.

Former Disposal Area Soil Alternatives

1. Overall Protection of Human Health and the Environment

Alternative FDA-S-1, No Action, and Alternative FDA-S-2, Institutional Controls, alone would not be protective since remedial action objectives would not be met. These alternatives will not be discussed further in this comparative analysis; they have been screened out on this basis.

Alternatives FDA-S-3 through FDA-S-7 would provide overall protection of human health and the environment. In the case of ex-situ volatilization, on-Site thermal desorption, and In-Situ SVE, effectiveness needs to be demonstrated through a treatability study. FDA-S-8 would be

protective of human health and the environment by removal of contaminated soils.

Alternatives FDA-S-3 through FDA-S-8 would provide an immediate benefit by minimizing the release of contamination to groundwater from the contaminated soils in the unsaturated zone and protecting humans from direct contact with contaminated soils.

Alternatives FDA-S-4 through FDA-S-8 provide the largest reduction in soil contamination and health-based risk on the Site through treatment of contamination above the clean up standards. The mass of contaminants in the soils would be reduced and the source of contamination to groundwater would be removed.

2. Compliance with ARARs

Alternatives FDA-S-3 through FDA-S-8 comply with chemical-, location-, and action-specific ARARs. A treatability study would be required for ex-situ volatilization, on-Site thermal desorption, and In-Situ SVE (Alternatives FDA-S-5, FDA-S-6, and FDA-S-7) to ensure that the treatment systems can adequately comply with the clean up levels.

3. Long-Term Effectiveness and Permanence

Alternatives FDA-S-3 through FDA-S-8 would be the most effective in the long-term since they incorporate treatment or removal of the soil, which is not a reversible process and does not require long-term maintenance. A treatability study would be required for ex-situ volatilization, on-Site thermal desorption, and In-Situ SVE.

Alternative FDA-S-3, Capping, would be effective in the long-term if a cap O&M program is maintained. If the integrity of the cap is compromised, the contaminants in the underlying soil could be reactivated as a source of groundwater contamination, and lead to future exposures above the health-based risk standard.

4. Reduction of Toxicity, Mobility, and Volume through Treatment

Alternatives FDA-S-4 through FDA-S-8, provide the most significant reduction in toxicity, mobility, and volume through treatment at the Former Disposal Area. Alternative FDA-S-3, Capping, does not employ treatment. The cap does provide a reduction in mobility, but does not provide a reduction in toxicity and contaminant volume.

5. Short-Term Effectiveness

A temporary increase in air emissions and construction traffic on nearby roads would occur during installation of the bituminous concrete cap under Alternative FDA-S-3, Capping. Construction workers would be required to use personal protective equipment.

Alternatives FDA-S-4 through FDA-S-8 would result in a temporary increase in fugitive emissions during construction. Construction workers would be required to use personal protective equipment.

For Alternative FDA-S-5, Excavation, Ex-Situ Volatilization, Re-Use as Backfill, Alternative FDA-S-6, Excavation, On-Site Thermal Desorption, Re-Use as Backfill, and Alternative FDA-S-7, In-Situ SVE, off-gas from the treatment system would possibly require treatment.

6. Implementability

All alternatives are technically implementable. However, implementability of any alternative that requires Institutional Controls may be affected due to legal considerations. Alternative FDA-S-3, Capping, incorporates standard construction practices, including grading and paving for the cap. An O&M program required for the cap incorporates standard construction practices.

Alternative FDA-S-4, Excavation, Off-Site Thermal Desorption, & Disposal at a Subtitle C Landfill, Alternative FDA-S-5, Excavation, Ex-Situ Volatilization, Re-Use as backfill, and Alternative FDA-S-6, Excavation, On-Site Thermal Desorption, Re-Use as backfill, and FDA-S-8, incorporate standard construction for excavation and backfill. A specialty contractor would be required for Alternative FDA-S-6, Excavation, On-Site Thermal Desorption, Re-Use as Backfill.

Alternative FDA-S-7, In-Situ SVE, incorporates standard construction practices. Routine O&M would include monthly sampling of extracted vapor and periodic changing of granular activated carbon for off-gas treatment.

Five year reviews would be required for FDA-S-3, Capping, since contaminated soils will remain on the Site. Five year reviews would be required for Alternative FDA-S-4, In-Situ SVE, during operation of the system.

7. Cost

Alternative	Total Cost
FDA-S-3	\$ 993,000
FDA-S-8	\$ 1,242,924
FDA S-5	\$ 2,787,000
FDA S-7	\$ 3,117,000
FDA S-6	\$ 3,858,000
FDA S-4	\$ 7,016,000

8. State Acceptance

The Commonwealth of Pennsylvania has had the opportunity to review and comment on all the documents in the Administrative Record and has participated in selecting the remedy for this Site. The Commonwealth has had the opportunity to comment on the draft ROD and, to the extent possible, the Commonwealth's comments have been incorporated into the ROD.

9. Community Acceptance

A public meeting on the Proposed Plan was held on July 16, 1997 at the Great Valley High School, East Whiteland Township, Pennsylvania. Comments received orally at the public meeting and in writing during the comment period were generally not in favor of EPA's proposed alternative FDA-S-8 for the Former Disposal Area soils. See Part III, Responsiveness Summary of this ROD for detailed comments and responses.

Former Disposal Area Groundwater Alternatives

1. Overall Protection of Human Health and Environment

Neither Alternative FDA-G-1, No Action, nor Alternative FDA-G-2, Institutional Controls, would provide long-term protection of human health and the environment. These will not be considered further.

Alternative FDA-G-5, Groundwater Collection, Treatment, and Discharge, would achieve overall protection of human health and the environment by interception, removal and treatment of contaminated groundwater. Alternative FDA-G-6, Groundwater Collection (Single Well), Treatment, and Discharge, would achieve overall protection of human health and the environment by capturing the most contaminated part of the plume. The remaining plume would be reduced by natural attenuation.

2. Compliance with ARARs

Alternative MPA-G-4, Natural Attenuation will comply with chemical-specific ARARs at the conclusion of the remedial action. Location-, and action-specific ARARs are not directly applicable for this alternative.

Alternative FDA-G-4, Natural Attenuation, has been shown to be effective in preventing the downgradient extension of the plume of contaminated groundwater. This alternative is a viable and effective solution which would satisfy the ARARs in the long-term.

Alternative FDA-G-5, Groundwater Collection, Treatment, and Discharge, and Alternative FDA-G-6, Groundwater Collection (Single Well), Treatment, and Discharge, would comply with chemical-, location-, and action-specific ARARs.

3. Long-Term Effectiveness and Permanence

Alternative FDA-G-5, Groundwater Collection, Treatment, and Discharge, and Alternative FDA-G-6, Groundwater Collection (Single Well), Treatment, and Discharge, would be the most effective in the long-term since they incorporate removal and treatment of the groundwater, which is not a reversible process.

Alternative FDA-G-4, Natural Attenuation, may be effective in the long-term. Contamination would be remediated by natural attenuation mechanisms over time and the progress would be tracked by groundwater monitoring.

4. Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative FDA-G-5, Groundwater Collection, Treatment, and Discharge, and Alternative FDA-G-6, Groundwater Collection (Single Well), Treatment, and Discharge, provide the most significant reduction in toxicity, mobility, and volume at the source area of the Former Disposal Area. FDA-G-6 ultimately relies on natural attenuation mechanisms to degrade the contaminant plume below MCLs.

Reduction of toxicity, mobility, and volume for Alternative FDA-G-4, Natural Attenuation, is dependant on natural attenuation mechanisms such as biological and abiotic attenuation. Abiotic

attenuation includes volatilization, sorption, hydrolysis, and dehalogenation.

5. Short-Term Effectiveness

Alternative FDA-G-4, Natural Attenuation, involves no construction or Site activities and would therefore produce no disturbance to the surrounding community and environment.

A temporary increase in air emissions and construction traffic on nearby roads would occur during installation of the groundwater treatment system under Alternative FDA-G-5, Groundwater Collection, Treatment, and Discharge, and Alternative FDA-G-6, Groundwater Collection (Single Well), Treatment, and Discharge. Construction workers would be required to use personal protective equipment. A temporary increase in fugitive emissions during treatment system operation would occur. Off-gas from the treatment system may require treatment.

6. Implementability

All alternatives are technically implementable. However, the implementability of any alternative requiring Institutional Controls may be affected due to legal considerations. Alternative FDA-G-4, Natural Attenuation, is readily implemented. Alternative FDA-G-5, Groundwater Collection, Treatment, and Discharge, and Alternative FDA-G-6, Groundwater Collection (Single Well), Treatment, and Discharge, incorporate standard construction practices and equipment is readily available.

Five year reviews would be required for Alternative FDA-G-4, Natural Attenuation since contaminated groundwater would remain on the Site. Five year reviews would be required for Alternative FDA-G-5, Groundwater Collection, Treatment, and Discharge, and Alternative FDA-G-6, Groundwater Collection (Single Well), Treatment, and Disposal, during operation of the systems or allowing the residual plume to degrade below MCLs.

7. Cost

FDA-G-4 is the least expensive at \$979,647 followed by FDA-G-6 at \$3,272,000 and FDA-G-5 at \$8,258,000.

8. State Acceptance

The Commonwealth of Pennsylvania has had the opportunity to review and comment on all the documents in the Administrative Record and has participated in selecting the remedy for this Site. The Commonwealth has had the opportunity to comment on the draft ROD and, to the extent possible, the Commonwealth's comments have been incorporated into the ROD.

9. Community Acceptance

A public meeting on the Proposed Plan was held on July 16, 1997 at the Great Valley High School, East Whiteland Township, Pennsylvania. Comments received were varied with respect to installation of a pump and treat system at the Former Disposal Area. Oral and written comments on the remedial alternatives evaluated by EPA for the implementation at the Site are included in Part III of this ROD.

X. SELECTED REMEDY AND PERFORMANCE STANDARDS

Based upon considerations of the requirements of CERCLA, the detailed analysis of the alternatives using the nine criteria, and public comments, EPA has determined the following to be the most appropriate remedy for the Site:

- A. *Water Supply:* To prevent contact with groundwater contamination at residences affected or potentially affected by the Site, EPA has selected **Alternative WS-G-3a, Public Water Supply.**
- B. *Main Plant Area Soils:* To prevent direct contact with contaminated soils in the Main Plant Area and to reduce the potential for continued migration of these contaminants to the groundwater, EPA has selected **Alternative MPA-S-3, Capping.**
- C. *Main Plant Area Groundwater:* To restore the Site groundwater to beneficial use through removal and treatment of contaminated groundwater. EPA has selected **Alternative MPA-G-6, Groundwater Collection, Treatment of Source Area, and Discharge.**
- D. *Former Disposal Area/Mounded Area Soils:* To reduce the potential for continued migration of contaminants in these soils to the groundwater, EPA has selected **Alternative FDA-S-4, Excavation, Off-Site Thermal Treatment, Disposal at a Hazardous Waste Landfill.**
- E. *Former Disposal Area/Mounded Area Groundwater:* To reduce concentrations of contaminants in groundwater to MCLs, EPA has selected **Alternative FDA-G-4, Natural Attenuation.**

The detailed requirements and performance standards associated with the selected remedy are presented below.

A. Water Supply Remedy and Performance Standards

- 1. A source of potable water shall be provided year round to the residents listed in Table 14 by extending the existing waterline to the area of concern in the vicinity of the Site. The Philadelphia Suburban Water Company (PWSC) currently supplies water to East Whiteland Township, and has sufficient capacity at this time to provide water. PWSC plans to install water mains in Phoenixville Pike from Aston Road to Conestoga Road, and to extend the existing main in Conestoga Road north to Bacton Hill Road by the end of 1997. Therefore, this portion of the remedy addresses connections to the water mains that will be in place prior to the implementation of the remedy. To provide the water supply to the affected residents in Hillbrook Circle, a secondary main will be required along with connections.
- 2. The water supply provided shall be in compliance with the Safe Drinking Water Act, 42 U.S.C. §§ 300(f)-300(j), and 40 C.F.R. § 141. The residences listed on Table 14 are those which EPA believes to have been impacted or have the potential to be impacted by the groundwater contamination from the Site. Approximately 52 residences are expected to be connected to the public water supply.

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3. The water supply system shall be constructed in compliance with PSWC, State and local requirements. At a minimum, the water line shall be installed in a trench below the freeze line and independent connections shall be brought from the main into each residence. All areas impacted by construction activities shall be graded, restored, and revegetated, as necessary.
4. Independent connections shall be brought from the main into each residence affected or potentially affected by the contaminated groundwater.
5. Fire hydrants shall be installed in accordance with existing East Whiteland Township requirements along the main into Hillbrook Circle and along Phoenixville Pike.
6. Following hook up, costs of public water usage shall be the responsibility of the residence.
7. The installation of the water line shall avoid, minimize, and mitigate impacts on floodplains and wetlands. The performance standard will be in compliance with Executive Order No. 11988 and 40 C.F.R. Part 6, Appendix A (regarding avoidance, minimization, and mitigation of impacts on floodplains) and Executive Order No. 11990 and 40 C.F.R. Part 6, Appendix A (regarding avoidance, minimization, and mitigation of impacts on wetlands).
8. The existing residential wells shall be abandoned in accordance with the requirements of the Pennsylvania Safe Drinking Water Act 25 Pa. Code Section 109.62 and consistent with PADEP's Public Water Supply Manual, Part II, Section 3.3.5.11 and Chester County Health Department Rules and Regulations Chapter 500 unless selected by EPA for long-term monitoring. Existing carbon filters installed and/or maintained by EPA shall be removed from the residences.
9. RCRA listed constituents are present in the groundwater. Therefore, management of the spent filters shall be in accordance with the substantive requirements of 25 Pa. Code Chapter 262 Subparts A (relating to hazardous waste determination and identification numbers); B (relating to manifesting requirements for off site shipments of spent carbon or other hazardous wastes); and C (relating to pretransport requirements; 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264, Subparts B-D, I (in the event that hazardous waste generated as part of the remedy is managed in containers); 25 Pa. Code Chapter 264, Subpart J (in the event that hazardous waste is managed, treated, or stored in tanks), and 40 C.F.R. 268 Subpart C, Section 268.30, and Subpart E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste).
10. All areas impacted by the construction activities during remedy implementation shall be graded, restored and revegetated to the extent practicable.
11. The use of groundwater impacted by the Site shall be restricted through the implementation of Institutional Controls, as set forth in Section X.C.7 and E.7-12.

B. Main Plant Area Soils Remedy and Performance Standards

1. *Cap:* The Main Plant Area shall be capped with a final cover designed and constructed to provide long-term minimization of migration of liquids into the Main Plant Area soils. The cap shall function with minimum maintenance and include a drainage layer to promote drainage and minimize erosion. The cap shall accommodate settling and subsidence and consist of a Flexible Membrane Liner (FML) or equivalent that achieves a permeability less than or equal to 1×10^{-7} cm/sec. The cap shall also be designed to facilitate other components of the remedy including the groundwater extraction and treatment system. The design of the cap should consider the existing use of the property.

The cap shall be installed over all areas of the Main Plant Area with surface or subsurface soil contaminated above any of the following levels:

<u>Contaminant</u>	<u>Soil Clean-up Standard (mg/kg)</u>
Trichloroethene (TCE)	0.70
1,1-Dichloroethene (1,1-DCE)	0.05
1,1-Dichloroethane (1,1-DCA)	0.39
Tetrachloroethene (PCE)	1.22
Vinyl Chloride	0.01
Methylene Chloride	0.50
Benzene	0.38
Ethylbenzene	74.00
Toluene	9.47
Xylene	8,790.00

These levels are based on an amount of residual contamination that if left in the soil, would not cause the groundwater to be contaminated above Maximum Contaminant Levels. See FS, Appendix B. The exact location and extent of the capped area shall be determined during remedial design. Any existing equipment or aboveground storage tanks in the area where the cap shall be placed shall be removed to complete the cap construction in accordance with the requirements above.

2. An O&M program shall be implemented to maintain the integrity of the cap for a period of 30 years. Maintenance shall include repairs to the cap as necessary to maintain the permeability standard, correct any breaches, or any effects of settling, subsidence or erosion. An operation and maintenance plan for the cap will be required, and is subject to approval by EPA in consultation with the Commonwealth of Pennsylvania.
3. *Structure Removal:* The existing quonset hut structure (former container storage area) has collapsed and is no longer acting as a cap to the soils beneath it. Therefore, the collapsed quonset hut shall be decontaminated and removed. Once the structure is removed, a representative sample shall be collected to determine if the quonset hut debris is hazardous under RCRA. If hazardous, the quonset hut debris shall be decontaminated in accordance with the Hazardous Debris Rule and properly disposed of or reused.

Soil sampling shall be conducted beneath the quonset hut to determine if soils are

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impacted above any of the clean up levels listed in B.1 above. The cap shall be extended to include this area, if soils are so impacted, and/or, in order to achieve the requirements set forth in (1) above.

4. *Tank Removal:*

Underground Storage Tanks

The former USTs previously excavated, and currently located on property adjacent to Chemclene, shall be decontaminated and properly disposed of or reused in accordance with RCRA. Representative samples shall be collected and analyzed to confirm decontamination. If the tanks continue to contain hazardous substances, they shall be shipped to a proper off-Site disposal facility in accordance with RCRA. If it is determined subsequent to decontamination that the tanks do not contain hazardous substances, the tanks may be reused or disposed offSite.

5. *Main Building:* The area occupied by the Main Building shall serve as a cap consistent with the Standards in (1) above. Presently, the building acts as a cap over an area of soils at the Main Plant. The building shall be inspected and maintained so as to reduce potential infiltration of precipitation to the extent possible and provide an effective cap over the soils at this area of the Site. If and when the building no longer reduces potential infiltration of precipitation and serves as an effective cap over the soils at the Main Plant Area, the building shall be removed, in accordance with the provisions set forth in this part.

In the event the building is removed, for any reason, soils beneath the removed building shall then be analyzed to determine if contamination is present above any of the clean up standards listed in B.1 above. If contamination is above clean up standards, the cap as set forth in (1), above shall be extended to cover this area.

6. *Closure of the Main Building (including Loading Dock and Chemical Laboratory):* The Main Building shall be closed in accordance with 25 Pa. Code 25 § 265.110 through 265.119, 265.442(7); 40 C.F.R. §§ 264.110 through 264.120, 264.178, 270.14(b)(13). Closure will consist of removal and proper disposal of all hazardous wastes; decontamination of the floor, related distillation equipment, contaminated structures (i.e. walls), and associated processing equipment. Contents of the building (i.e. process equipment, lab chemicals, etc.) shall be sampled to determine if hazardous substances are present. If hazardous substances are present, the material shall be shipped to a proper off-Site disposal facility in accordance with RCRA.
7. Wastewater generated during decontamination activities shall be properly managed in accordance with Pennsylvania Hazardous Waste Management regulations and/or the Clean Water Act.
8. Fugitive dust emissions generated during remedial activities will be controlled in order to comply with fugitive dust regulations in the federally-approved State Implementation Plan (SIP) for the Commonwealth of Pennsylvania, 25 Pa. Code §§ 123.1 - 123.2 and the National Ambient Air Quality Standards for Particulate Matter in 40 C.F.R. §§ 50.6 and Pa. Code §§ 131.2 and 131.3.

8. The Main Plant Area perimeter fence shall be maintained to prevent trespassing and access to the Site during construction. The fence shall be maintained for 30 years to prevent unauthorized access to the capped area.
9. The cap shall not be breached or adversely affected. The capped area may continue to be used for commercial operations or other activities as long as the cap is not adversely affected. Institutional Controls shall be implemented to accomplish this.

C. Main Plant Area Groundwater Remedy and Performance Standards

1. Groundwater Remediation

The groundwater affected by contamination originating at the Main Plant Area shall be remediated through extraction and treatment. Extraction well(s) shall be designed to remediate the dissolved contaminant plume to MCLs listed in C.2 below. The exact number and location of extraction well(s) shall be determined during the remedial design phase. The degree to which natural attenuation can be incorporated into the pump and treat system will be determined during remedial design. A portion of the extraction system shall be positioned to collect potential DNAPLs in the area of existing monitoring wells CC-6 and CC-7. DNAPLs shall be contained if present, extracted to the degree practicable, and disposed of off-Site.

2. Groundwater Treatment

a) The groundwater plume at the Main Plant Area shall be remediated until the MCL or the non zero MCLG (whichever is more stringent) for all the contaminants of concern [40 C.F.R. part 141] is achieved. Since most CoPCs at the Site are members of the same general class of chemicals and possess similar physical and chemical properties, the selected treatment remedy at the Site will likely reduce or eliminate all contaminants posing potential risks. The performance standards for the contaminants in the groundwater at the Main Plant Area are listed below:

<u>Contaminant</u>	<u>MCL (ug/l)</u>	<u>MCLG (ug/l)</u>
Chloroform	100	0
Trichloroethene (TCE)	5	0
1,1-Dichloroethene (1,1-DCE)	7	7
1,2-Dichloroethane (1,2-DCA)	5	0
Tetrachloroethene (PCE)	5	0
Vinyl Chloride	2	0

b) Recovered groundwater shall be treated and reduced to MCLs via air stripping followed by vapor phase granular activated carbon or U/V oxidation prior to reinjection. The treatment system shall reduce the contaminants in the extracted groundwater, unattended, on a continuous, 24-hour-per-day performance basis. A treatment plant shall be capable of handling high contaminant concentrations because of the potential presence of DNAPLs. A pilot study shall be conducted to determine the appropriate treatment method to conform with drinking water standards. The final pumping rate and the exact location, size, and number of extraction wells shall be determined during remedial design. Final design criteria for the air stripper treatment system will be determined by EPA in consultation with PADEP. The design, construction and operation of the treatment

system shall consider and reduce the possible visual and noise impacts to the surrounding residences. The design, construction and operation of the treatment system shall be in harmony with the surrounding community to the extent practicable.

c) The treated groundwater effluent shall be discharged to reinjection wells located to maximize the performance of the remedy in 2.a above. The treated groundwater effluent shall be reinjected in accordance with "Applicability of Land Disposal Restrictions to RCRA and CERCLA Groundwater Treatment Reinjection", OSWER Directive #9234.1-06. The final number of injection wells, and their locations and configurations, shall be determined in a pre-design study.

d) Any VOC emissions from the air stripper tower will be in accordance with the Pennsylvania Department of Environmental Protection air pollution regulations outlined in 25 Pa. Code §§ 121.1 - 121.3, 121.7, 123.1, 123.2, 123.31, 123.41, 127.1, 127.11, 127.12, and 131.1 - 131.4. 25 Pa. Code § 127.12 requires all new air emission sources to achieve minimum attainable emissions using the best available technology (BAT). In addition, the PADEP air permitting guidelines for remediation projects require all air stripping and vapor extraction units to include emission control equipment. Federal Clean Air Act requirements, 42 U.S.C. §§ 7401 *et seq.*, are applicable and must be met for the discharge of contaminants to the air. Air permitting and emissions ARARs are outlined in 40 C.F.R. §§ 264.1030 - 264.1034 (Air Emissions Standards for Process Vents), and 40 C.F.R. §§ 264.1050 - 264.1063 (Air Emissions Standards for Equipment Leaks). Air emissions of vinyl chloride will comply with 40 C.F.R. Parts 61.60 - 61.69, National Emission Standards for Hazardous Air Pollutants (NESHAPS). OSWER Directive #9355.0-28, Control of Air Emissions from Superfund Air Strippers at Superfund Ground Water Sites, is a "to be considered" (TBC) requirement.

e) Management of waste from the operation of the treatment system (i.e. spent carbon units, DNAPLs) shall comply with the requirements of: 25 Pa. Code Chapter 262 Subparts A (relating to hazardous waste determination and identification numbers); B (relating to manifesting requirements for off site shipments of spent carbon or other hazardous wastes); and C (relating to pretransport requirements); 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264, Subparts B-D, I (in the event that hazardous waste generated as part of the remedy is managed in containers); 25 Pa. Code Chapter 264, Subpart J (in the event that hazardous waste is managed, treated or stored in tanks); and 40 C.F.R. 268 Subpart C, Section 268.30, and Subpart E (regarding prohibitions on land disposal and prohibitions on storage of hazardous waste).

3. The extraction and treatment system shall avoid, minimize, and mitigate impacts on floodplains and wetlands. The performance standard will be in compliance with Executive Order No. 11988 and 40 C.F.R. Part 6, Appendix A (regarding avoidance, minimization and mitigation of impacts on floodplains) and Executive Order No. 11990 and 40 C.F.R. Part 6, Appendix A (regarding avoidance, minimization, and mitigation of impacts on wetlands).
4. Fugitive dust emissions generated during remedial activities will be controlled in order to

comply with fugitive dust regulations in the federally-approved State Implementation Plan (SIP) for the Commonwealth of Pennsylvania, 25 Pa. Code §§ 123.1 - 123.2, and the National Ambient Air Quality Standards for Particulate Matter in 40 C.F.R. §§ 50.6 and Pa. Code §§ 131.2 and 131.3

5. The extraction and reinjection systems shall achieve the substantive requirements of the Delaware River Basin Commission (DRBC) (18 C.F.R. Part 430). These regulations establish requirements for the extraction and discharge of groundwater within the Delaware River Basin. However, modifications to the Selected Remedy as a result of the DRBC requirements are not anticipated.
6. *Monitoring*
 - a) The performance of the extraction and treatment system shall be monitored through the use of monitoring wells. EPA, in consultation with PADEP, will determine if additional monitoring wells are necessary to determine the extent of the groundwater plume or performance of the system.
 - b) At least one round of samples shall be collected from existing Site monitoring wells as well as any additional monitoring wells installed, during the predesign phase, and analyzed for VOCs, in order to determine the extent of groundwater contaminant plume at that time. Any new wells installed must be drilled in accordance with 25 Pa. Code Chapter 107. These regulations are established pursuant to the Water Well Drillers License Act, 32 P.S. § 645.1 et seq.
 - c) An operation and maintenance plan shall be developed for the groundwater extraction system during the remedial design phase. The operation and maintenance plan shall be developed and implemented to determine the operation and performance of the system within design criteria and achievement of performance standards. At a minimum, the influent and effluent from the treatment facility shall be sampled twice per month for VOCs. Operation and maintenance of the groundwater extraction system shall continue for an estimated 30 years or such other time period as EPA, in consultation with PADEP, determines to be necessary, based on the statutory reviews of the remedial action conducted every five years from the initiation of the remedial action. The performance of the groundwater extraction and treatment system shall be carefully monitored on a regular basis, as described below in the Section 6.g of this Selected Remedy. The system may be modified, as warranted by performance data during operation to achieve Performance Standards. These modifications may include for example, alternate pumping of extraction well(s), the addition or elimination of certain extraction wells and, changes in reinjection location.
 - d) The operation and maintenance plan shall be revised after construction of the treatment system has been completed if it is determined to be necessary by EPA.
 - e) Five year statutory reviews under Section 121(c) of CERCLA shall be required, as long as hazardous substances remain on-Site and prevent unlimited use and unrestricted access to the Site. Five year reviews shall be conducted at the initiation of the remedial action in accordance with EPA guidance document, *Structure and Components of Five-Year Reviews* (OSWER Directive 9355.7-02, May 23, 1991).

f) Existing pumping and/or monitoring wells which serve no useful purpose shall be properly plugged and abandoned consistent with PADEP's Public Water Supply Manual, Part II, Section 3.3.5.11 and Chester County Health Department Rules and Regulations Chapter 500, in order to eliminate the possibility of these wells acting as a conduit for future groundwater contamination. Wells which EPA determines are necessary for use during the long term monitoring program will not be plugged.

g) A long-term groundwater monitoring program shall be implemented to evaluate the effectiveness of the groundwater extraction and treatment system at the Main Plant Area.

i) The plan for the long-term groundwater monitoring program shall be included in the operation and maintenance plan for the groundwater extraction and treatment system. The plan shall include the sampling of a sufficient number of wells to monitor the effectiveness of the remedial action. EPA, in consultation with PADEP, will determine the number and location of monitoring wells necessary to verify the performance of the remedial action.

ii) The installation of additional monitoring wells will be required. Numbers and locations of these monitoring wells shall be determined by EPA during the remedial design, in consultation with the PADEP.

iii) The wells shall be sampled quarterly for the first three years. Based on the findings of the first three years of sampling, the appropriate sampling frequency for subsequent years will be determined by EPA, in consultation with the PADEP.

iv) Sampling and operation and maintenance shall continue until such time as EPA, in consultation with PADEP, determine that the performance standard for each contaminant of concern has been achieved throughout the entire area of groundwater contamination.

v) If EPA, in consultation with PADEP, makes such determination, the wells shall be sampled for twelve consecutive quarters throughout the entire plume and if contaminants remain at or below the performance standards, the operation of the extraction system shall be shut down.

vi) Annual monitoring of the groundwater shall continue for five years after the system is shutdown.

vii) If subsequent to an extraction system shutdown, annual monitoring shows that groundwater concentrations of any contaminant of concern are above the Performance Standard set forth above, the system shall be restarted and continued until the performance standards have once more been attained for twelve consecutive quarters. Annual monitoring shall continue until EPA determines, in consultation with the PADEP, that the Performance Standards in 2.a above for each contaminant of concern has been achieved on a continuing basis.

7. *Institutional Controls*

No newly commenced or expanded groundwater pumping in the aquifer shall be

implemented which will adversely affect the plume migration. The Site shall be identified as property underlain by contaminated groundwater. Human consumption of contaminated groundwater shall be prevented. Institutional Controls shall be implemented to achieve these items.

D. Former Disposal Area/Mounded Area Soils Remedy and Performance Standards

1. All soils with contaminant concentrations exceeding any of the following soil clean-up performance standards shall be excavated and removed from the Former Disposal Area/Mounded Area:

<u>Contaminant</u>	<u>Soil Clean-up Standard (mg/kg)</u>
Trichloroethylene (TCE)	0.70
1,1-Dichloroethene (1,1-DCE)	0.05
1,1-Dichloroethane (1,1-DCA)	0.39
1,1,1 Trichloroethane (1,1,1 TCA)	45.00
Tetrachloroethene (PCE)	1.22
Vinyl Chloride	0.01
Methylene Chloride	0.50
PCBs	1.00

Since most CoPCs at the Site are members of the same general class of chemicals and possess similar physical and chemical properties, the selected remedy at the Site will likely reduce or eliminate all contaminants posing potential risks. An estimated 5,700 cubic yards of soil with contaminant concentrations exceeding the above performance standards is present at the Former Disposal Area/Mounded Area. Additional sampling shall be performed during the remedial design to determine the full extent of required excavation of the subsurface soil contamination. During the previous investigations at the Former Disposal Area/Mounded Area, low level PCB contamination was detected in surface samples, however, subsurface soils were not fully characterized for PCBs during the RI. Therefore, any sampling conducted during the remedial design will require PCB analysis. The number and location of the soil samples, the analytical parameters, and methods will be determined by EPA, in consultation with PADEP, during the remedial design phase.

2. Structural stability of open excavations shall be maintained with temporary shoring or engineering measures as appropriate. Excavation will begin using a backhoe, and the sides of the excavation area shall be cut back to a minimum 2 to 1 slope to prevent side wall failure. Air monitoring shall be conducted during excavations to ensure safety of Site workers and nearby residents living in the vicinity of the Site.
3. Sediment and erosion controls and temporary covers will be installed to protect exposed soil from the effects of weather consistent with PADEP's Bureau of Soil and Water Conservation Erosion and Sediment Pollution Control Manual. Erosion potential shall be minimized. Further, controls in the form of Site grading to improve land grades, cover soils, vegetation, and drainage channels to reduce erosion potential from surface runoff may be required to minimize erosion. Contaminated soils shall be prevented from being

washed into on-Site surface water and adjacent uncontaminated and uncontrolled wetland areas during remedial action implementation. The extent of erosion control necessary will be determined by EPA, in consultation with the PADEP, during the remedial design phase.

4. Post-excavation sampling will be performed after the excavation is completed. Post-excavation samples will be obtained from the base and the sidewalls of the excavation to ensure that contamination is not present above the soil clean-up Performance Standards specified in D.1. The location of the post-excavation samples will be selected based on visual observation of lithology and screening for VOCs using an appropriate organic vapor detector. The samples will be analyzed for VOCs and PCBs on a quick turnaround basis using a method approved by EPA.
5. If the post-excavation sample concentrations are below all the clean-up levels, the excavation will be backfilled using clean soil. Clean borrow material will be brought in to restore the excavation to original grade. Backfilling will be performed, and the material will be compacted to minimize the potential for subsidence. The excavation area shall be covered with a layer of cover soil and revegetated with native plant material until a viable cover is established. Any on Site landscaping will be in accordance with Office of the Federal Executive; Guidance for Presidential Memorandum on Environmentally and Economically Beneficial Landscape Practices on Federal Landscaped Grounds, 60 Fed. Reg. 40837 (August 10, 1995) which is a "to be considered" (TBC) requirement.
6. If VOCs or PCBs are detected at levels above any of the soil clean up Performance Standards in the post-excavation samples, additional material will be removed from the excavation area and new samples obtained for analysis as discussed in D.1. Excavation and sampling activities will continue until the results indicate that the soils do not contain contaminants of concern above any of the performance standards. The excavation area will then be restored as described in D.5.
7. RCRA listed constituents will exist in the excavated soil, therefore, the remedy will be implemented consistent with the following substantive requirements, which are applicable to on-Site activities, of Pa. Code §§ 262.11 - 262.13 (relating to hazardous waste determination and identification numbers), 25 Pa. Code § 262.34 (relating to pretransport requirements); 25 Pa. Code Chapter 263 (relating to transporters of hazardous wastes); and with respect to the operations at the Site generally, with the substantive requirements of 25 Pa. Code Chapter 264, Subparts B-D, I (in the event that hazardous waste is generated as part of the remedy).
8. Fugitive dust emissions generated during remedial activities will be controlled in order to comply with fugitive dust regulations in the federally-approved State Implementation Plan (SIP) for the Commonwealth of Pennsylvania, 25 Pa. Code §§ 123.1 - 123.2. and the National Ambient Air Quality Standards for Particulate Matter in 40 C.F.R. §§ 50.6 and Pa. Code §§ 131.2 and 131.3

E. Former Disposal Area/Mounded Area Groundwater Remedy and Performance Standards

1. A Natural Attenuation groundwater monitoring program shall be implemented to determine that natural attenuation is occurring, and that the groundwater plume will not enlarge or migrate into areas not presently affected by the source area at the Former Disposal Area/Mounded Area. Monitoring shall be conducted until the MCL or the non-zero MCLG for all the the contaminants of concern [40 C.F.R. part 141] whichever is more stringent is achieved. Since most CoPCs at the Site are members of the same general class of chemicals and possess similar physical and chemical properties, the selected remedy at the Site will likely reduce or eliminate all contaminants posing potential risks.

The performance standard for the contaminants in the groundwater are listed below:

<u>Contaminant</u>	<u>MCL (ug/l)</u>	<u>MCLG (ug/l)</u>
Chloroform	100.0	0
Trichloroethene	5.0	0
1,1-Dichloroethene (1,1-DCE)	7.0	2
1,2-Dichloroethane (1,2-DCA)	5.0	0
Tetrachloroethene (PCE)	5.0	0

2. The Natural Attenuation program shall include the sampling to monitor the effectiveness of the Natural Attenuation program. Monitoring shall include sampling of the groundwater discharging to Valley Creek and surface water within Valley Creek to ensure that the groundwater plume does not impact the creek. The necessary monitoring shall be determined during Remedial Design and shall be provided in a Natural Attenuation Monitoring Plan. EPA, in consultation with PADEP, will determine the number and location of monitoring wells, number and location of creek samples, and monitoring parameters necessary to verify the performance of the remedial action. Installation of additional wells may be necessary and must be in accordance with 25 Pa. Code Chapter 107. These regulations are established pursuant to the Water Well Drillers License Act, 32 P.S. § 645.1 et seq.
3. The wells and creek sampling points shall be sampled quarterly for the first three years. The samples shall be analyzed for VOCs and natural attenuation parameters at each sampling location. The natural attenuation parameters will be determined by EPA in consultation with PADEP during Remedial Design. Based on the findings of the first three years of sampling, the appropriate sampling frequency for subsequent years will be determined by EPA in consultation with the PADEP.
4. Monitoring shall continue until such time as EPA, in consultation with PADEP, determine that the performance standard for each contaminant of concern has been achieved. If EPA and the Commonwealth make such a determination, the wells shall be sampled for twelve consecutive quarters throughout the entire plume and if contaminants remain at or below the performance standards, the monitoring program shall be discontinued.

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5. Five year statutory reviews under Section 121 (c) of CERCLA will be required, as long as hazardous substances remain onsite and prevent unlimited use and unrestricted access to the Site. Five year reviews shall be conducted at the initiation of the remedial action in accordance with EPA guidance document, *Structure and Components of Five-Year Reviews* (OSWER Directive 9355.7-02, May 23, 1991).
6. Existing monitoring wells which serve no useful purpose shall be properly plugged and abandoned consistent with PADEP's Public Water Supply Manual, Part II, Section 3.3.5.11 and Chester County Health Department Rules and Regulations Chapter 500, in order to eliminate the possibility of these wells acting as a conduit for future groundwater contamination and to prevent adverse impacts to the remedy. Wells which EPA determines are necessary for use during the long term monitoring program will not be plugged.
7. No newly commenced or expanded groundwater pumping in the aquifer shall be implemented which will adversely affect the plume migration. Institutional controls will be used to identify the Site as property underlain by contaminated groundwater, and to prevent the human consumption of contaminated ground water.
8. Drinking water supply wells shall not be installed in the area of the contaminated groundwater plume.
10. No new development at or near the Site shall adversely affect the natural hydraulic containment and plume migration.
11. Title restrictions along with other appropriate means shall be used to implement the requirements above.
12. Title restrictions will be appropriately recorded with the Chester County Recorder of Deeds.

FUTURE POSSIBLE CHANGES IN ACCORDANCE WITH NCP

Groundwater Extraction and Treatment System

It may become apparent during implementation or operation of the groundwater extraction system and its modifications, that contaminant levels have ceased to decline and are remaining constant at levels higher than Performance Standards over some portion of the contaminant plume originating from the Main Plant Area. If EPA, in consultation with PADEP, determines that implementation of the selected remedy demonstrates, in corroboration with hydrogeological and chemical evidence, that it will be technically impracticable to achieve and maintain the Performance Standards throughout any part of the contaminant plume, EPA, in consultation with PADEP, may require that any or all of the following measures be taken, for an indefinite period of time, as further modification(s) of the existing system:

- a) long-term gradient control provided by modified pumping, as a containment measure;

- b) chemical-specific ARARs may be waived for those portions of the aquifer that EPA determines, in consultation with PADEP, are technically impracticable to achieve. Such determinations shall be reevaluated at each subsequent five-year review;
- c) institutional controls may be provided/maintained to restrict access to those portions of the aquifer where contaminants remain above performance standards; and
- d) remedial technologies for groundwater restoration may be reevaluated.

The decision to invoke any or all of these measures may be made during implementation or operation of the remedy or during the 5-year reviews of the remedial action. If such a decision is made, EPA shall amend the ROD or issue an Explanation of Significant Differences.

Natural Attenuation

It may become apparent during implementation of the Natural Attenuation program that contaminant levels have ceased to decline and are remaining constant at levels higher than Performance Standards over some portion of the contaminant plume. EPA, in consultation with PADEP, may require that any or all of the following measures be taken, for an indefinite period of time, as further modification(s) of the remedial action:

- a) chemical-specific ARARs may be waived for those portions of the aquifer that EPA determines, in consultation with PADEP, are technically impracticable to achieve. Such determinations shall be reevaluated at each subsequent five-year review;
- b) institutional controls may be provided/maintained to restrict access to those portions of the aquifer where contaminants remain above performance standards; and
- c) remedial technologies for groundwater restoration may be reevaluated.

The decision to invoke any or all of these measures set forth above may be made during implementation or operation of the remedy or during the 5-year reviews of the remedial action. If such a decision is made, EPA shall amend the ROD or issue an Explanation of Significant Differences.

XI. STATUTORY DETERMINATIONS

The following sections discuss how the selected remedy for the Malvern TCE Site meets these statutory requirements.

A. Protection of Human Health and the Environment

Based on the Baseline Human Health Risk Assessment for the Site, measures should be considered to reduce potential risk from the following sources: (1) VOCs in the groundwater and (2) VOCs in subsurface soils. These media and contaminants were selected because potential health hazards for some exposure scenarios exceeded the EPA target range of 1.0×10^{-4} (or 1 in

10,000), and 1.0×10^{-6} (or 1 in 1,000,000) for lifetime cancer risk or a non-cancer Hazard Index of one (1). The results of the Ecological Risk Assessment show the potential for risk to ecological receptors; however, the selected remedy will address this concern.

The extension of a public water supply called for in the selected remedy will provide a permanent alternative water supply to affected and potentially affected residences and businesses which will prevent current human exposure to groundwater contaminants. However, it will not actively reduce the contaminants in the soil or groundwater, or prevent migration of contaminated groundwater from the source areas of the Site.

The installation of a cap over soil at the Main Plant Area will reduce the infiltration of precipitation, thereby eliminating the potential for contaminant migration to the groundwater and preventing future exposure through ingestion, inhalation and dermal contact of groundwater.

The selected remedy protects human health and the environment at the Main Plant Area of the Site by reducing levels of contaminants in the groundwater to those levels required by ARARs through extraction and treatment. The groundwater extraction and treatment system shall reduce the levels of contaminants of concern in the groundwater to achieve MCLs as required by the Safe Drinking Water Act, 42 U.S.C. §§ 300(f) - 300(j), and 40 C.F.R. § 141.61. Reinjection of treated groundwater will not adversely affect human health or the environment, provided that all Performance Standards and ARARs are met.

The excavation of soil at the Former Disposal Area will protect human health and the environment by removing the contaminated soil, thereby eliminating the potential for contaminant migration to the groundwater and preventing future exposure through ingestion, inhalation and dermal contact.

The selected remedy protects human health and the environment at the Former Disposal Area by reducing levels of contaminants in the groundwater to those levels required by ARARs through Natural Attenuation. Natural Attenuation shall reduce the levels of contaminants of concern in the groundwater to achieve MCLs as required by the Safe Drinking Water Act, 42 U.S.C. §§ 300(f) - 300(j), and 40 C.F.R. § 141.61. Reinjection of treated groundwater will not adversely affect human health or the environment, provided that all Performance Standards and ARARs are met.

Implementation of the selected remedy will not pose any unacceptable short term risks or cross media impacts to the Site, or the community.

B. Compliance with and Attainment of Applicable or Relevant and Appropriate Requirements ("ARARs")

The selected remedy will comply with all applicable or relevant and appropriate chemical-specific, location-specific and action-specific ARARs as discussed above in Section X of this ROD and summarized on Table 13.

C. Cost-Effectiveness

The selected remedy is cost-effective in providing overall protection in proportion to cost, and meets all other requirements of CERCLA. Section 300.430(f) (ii) (D) of the NCP requires EPA to evaluate cost-effectiveness by comparing all the alternatives which meet the threshold criteria - protection of human health and the environment and compliance with ARARs - against three additional balancing criteria: long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; and short-term effectiveness. The selected remedy meets these criteria and provides for overall effectiveness in proportion to its cost.

- *Water Supply: Alternative WS-G-3a, Public Water Supply, \$505,971.*
- *Main Plant Area Soils: Alternative MPA-S-3, Capping, \$940,441.*
- *Main Plant Area Groundwater: Alternative MPA-G-6, Groundwater Collection, Treatment of Source Area, and Discharge, \$6,280,000.*
- *Former Disposal Area/Mounded Area Soils: Alternative, FDA-S-4, Excavation, Off-Site Thermal Treatment, Disposal at a Hazardous Waste Landfill, \$7,016,000.*
- *Former Disposal Area/Mounded Area Groundwater: FDA-G-4, Natural Attenuation, \$786,739.*

The combined estimated present worth cost for the selected remedy presented in this Record of decision is **\$15,529,151**. The proposed plan estimated that the preferred alternative would cost \$14,592,000. The difference in estimated costs from the Proposed Plan to this ROD is primarily due to the remedy changes outlined in Section XII of this ROD (page 67).

D. Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized while providing the best balance among the other evaluation criteria. Of those alternatives evaluated that are protective of human health and the environment and meet ARARs, the selected remedy provides the best balance of tradeoffs in terms of long-term and short-term effectiveness and permanence, cost effectiveness, implementability, reduction in toxicity, mobility, or volume through treatment, State and community acceptance, and preference for treatment as a principal element.

Under the selected remedy, groundwater extraction through source and migration control wells and treatment of groundwater using air stripping is more cost-effective than the other alternatives evaluated. The selected remedy will reduce contaminant levels in the Class IIA aquifer, a known source of drinking water, and reduce the risks associated with ingestion and inhalation of the groundwater to the maximum extent practicable, as well as provide long-term effectiveness.

The selection of excavation and off-Site disposal of contaminated soils at the FDA,

provides the best balance of trade offs among the nine NCP selection criteria. The remedy provides the highest degree of long-term effectiveness and permanence, reduces mobility and reduces risk to human health and the environment.

The selected remedy for the Main Plant Area provides the highest feasible degree of long-term effectiveness and permanence, reduces mobility and reduces risk to human health and the environment. Cleanup of Main Plant Area soils is particularly challenging since they contain high levels of complex contamination down to 100 feet deep (see section VI.A, pp. 6 - 9). Accordingly, the alternatives of excavation and off-site treatment and disposal, or, several possible in-situ treatment methods for these soils, were considered infeasible and screened out during the Feasibility Study. Soil vapor extraction (SVE) was evaluated carefully by EPA, as Alternative MPA-S-4. However, EPA concluded that although it may have been possible to remediate some of these soils using this method, the selected remedy of capping provides an equivalent level of protection and long-term effectiveness. The soil capping remedy will be combined with long-term institutional controls and a groundwater remedy designed to achieve and maintain MCLs. An on-going business also operates in the area of the soil contamination. EPA therefore has attempted to utilize permanent solutions and alternative treatment technologies to the maximum extent practicable for the unique conditions at the Main Plant Area.

E. Preference for Treatment as a Principal Element

The selected remedy satisfies, in part, the statutory preference for treatment as a principal element. The contaminated groundwater alternative (MPA-G-6) addresses the primary threat of future ingestion and inhalation of contaminated groundwater through treatment using air stripping. In addition, the soils at the Former Disposal Area/Mounded Area will be treated off-Site prior to disposal.

XII. DOCUMENTATION OF CHANGES FROM PROPOSED PLAN

The Proposed Plan identifying EPA's preferred alternative for the Site was released for comment on June 23, 1997. During the public comment period, EPA received numerous comments from the responsible parties and local community regarding EPA's Proposed Remedy. The changes discussed below are detailed in Part III of this ROD. (See Part III of this ROD) The selected remedy described in this ROD differs from the remedy in the Proposed Plan with regard to the following:

1) *Main Plant Area Soils*: EPA has reconsidered adoption of SVE at the Main Plant Area soils. EPA believes that although it may have been possible to remediate some of the soils at the Main Plant, the selected remedy (S-3, Capping) provides an equivalent level of protection and long-term effectiveness as the originally proposed remedy, while being more cost effective.

2) *Former Disposal Area/Mounded Area Soils*: EPA has reconsidered the movement of contaminated soils from the Former Disposal Area/Mounded Area to the Main Plant Area for consolidation. As a result, EPA has modified the preferred remedy and has selected FDA-S-4, Excavation, Off-Site Thermal Treatment and Disposal at a Hazardous Waste Treatment and Disposal Facility. Although the selected remedy for the soils is more costly than EPA's originally preferred remedy, EPA believes this modification provides the best balance of tradeoffs in long-term and short-term effectiveness and permanence, cost effectiveness,

implementability, reduction in toxicity, mobility, or volume through treatment, State and Community acceptance, and preference for treatment as a principal element.

3) *Former Disposal Area/Mounded Area Groundwater*: During the public comment period, EPA received numerous comments regarding the extraction and treatment of groundwater at the Former Disposal Area/Mounded Area. As a result, EPA again reviewed the available data regarding the natural attenuation of groundwater at the Former Disposal Area/Mounded Area. Based upon this review, EPA has made a modification from the Proposed Remedy and has selected FDA-G-4. EPA believes that FDA-G-4 provides an equivalent level of protection and long-term effectiveness as the originally proposed remedy, while being more cost effective.

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APPENDIX A - TOXICOLOGICAL PROFILES OF SELECTED SITE CONTAMINANTS

Carbon Tetrachloride (Tetrachloroethane)

Tetrachloroethane (TCA), more commonly referred to as carbon tetrachloride, is a clear, heavy liquid with a sweet aromatic odor. It is a synthetic chemical with no natural sources. Because it evaporates very easily, it is not usually encountered in its liquid state in the environment. Carbon tetrachloride is readily absorbed from the gastrointestinal tract and more slowly absorbed through the lungs and skin. Most carbon tetrachloride leaves the body by being exhaled through the lungs within a few hours after exposure.

Acute exposures of carbon tetrachloride to humans have shown a wide range of effects. Prior exposure to alcohol, phenobarbital, and some pesticides have been shown to increase the effects of carbon tetrachloride. Single exposures to low concentrations may cause symptoms such as irritation of the eyes, moderate dizziness and headache which disappear once exposure is discontinued. Exposure to higher concentrations will cause the same symptoms as above, but additional symptoms of nausea, loss of appetite, mental confusion, agitation and the feeling of suffocation may be seen. Chronic exposure to carbon tetrachloride produces symptoms of fatigue, lassitude, giddiness, anxiety, headache and muscle twitching. Organ damage is usually restricted to the liver, although there are some reported cases of kidney damage. After chronic exposure there is usually regeneration in these organs. Carbon tetrachloride is carcinogenic in animals producing mainly liver tumors. The USEPA has classified carbon tetrachloride as a group B2 carcinogen indicating that, based on animal studies, it is probably a human carcinogen, although there are no adequate studies of cancer in humans.

Most carbon tetrachloride is released to the environment in the atmosphere. Although it is moderately soluble in water, its high rate of volatilization results in only about 1% of the total carbon tetrachloride in the environment being in surface waters and oceans. Likewise, carbon tetrachloride tends to volatilize from tap water used for showering, bathing and cooking inside a home (ATSDR, 1989a).

1,1-Dichloroethene (1,1-DCE)

1,1-DCE is used to make certain plastics, such as packaging materials and flexible films like SARAN wrap, and flame-retardant coatings for fiber and carpet backing. It is a clear, colorless liquid and has a mild, sweet smell like chloroform. 1,1-DCE is considered highly volatile and readily migrates to the atmosphere, where it is photo-oxidized by reaction with hydroxyl radicals. It readily volatilizes through the air-filled pores in near-surface soils. Based on a soil sorption coefficient (K_{oc}) value of 65, this compound is expected to be only weakly sorbed to soils. This compound is not expected to undergo hydrolysis or microbial degradation in natural systems. In unsaturated near-surface soils, depending on several factors, including percent organic material, about 60 percent of the compound is expected in the gaseous phase, with only 3 percent in the aqueous phase and the remainder absorbed to soil. In deeper soils, 78 percent of the compound is expected to be in the aqueous phase. That portion of the compound that does not volatilize from soil may be expected to be mobile in groundwater.

EPA reports a chronic oral RfD of 9.0×10^{-3} mg/kg-day with the stipulation that the RfD is currently under review (IRIS, 1995). This RfD has an uncertainty factor (UF) of 1000. The confidence in the study, the database, and the RfD is medium. EPA lists the same value for the

interim subchronic RfD (HEAST, 1992). No inhalation RfCs are available, however a risk assessment for this compound is under review by an EPA work group (IRIS, 1995).

The oral RfDs were derived from a chronic oral bioassay in which rats were provided drinking water containing either 50, 100, or 200 mg/L 1,1-dichloroethene. The authors calculated intakes to be 7, 10, and 20 mg/kg/day for male rats and 9, 14, and 30 mg/kg/day for female rats (IRIS, 1995). The female rats evidenced hepatic lesions at all exposure levels, while the males only showed a significant effect at 200 mg/L. Therefore, the LOAEL was set at 9 mg/kg-day; a NOAEL could not be determined.

1,1-DCE has been classified by EPA (IRIS, 1995) as a group C (possible human) carcinogen. This classification indicates limited evidence of carcinogenicity in animals with inadequate evidence of human carcinogenicity and is based on the results of tumors observed in one mouse strain following an inhalation exposure to 25 ppm of 1,1-DCE for 5 days/week for 52 weeks (IRIS, 1995). EPA has established an oral CSF of $0.6 \text{ (mg/kg/day)}^{-1}$ (IRIS, 1995) and an inhalation Carcinogenic Slope Factor (CSF) of $0.18 \text{ (mg/kg/day)}^{-1}$ (IRIS, 1995). The oral CSF is only valid if the water concentration is below 600 mg/L, and the inhalation CSF is only valid if the air concentration is less than 200 mg/m^3 .

EPA lists a one-day health advisory of 2 mg/L and a ten-day health advisory of 1 mg/L (Drinking Water Standards and Health Advisories). The ambient water quality criteria for water and fish consumption is $3.3 \times 10^{-2} \text{ mg/L}$ and for fish ingestion only is 1.85 mg/L.

EPA (1986) reports an acute concentration of 11,600 mg/L for the dichloroethenes as the LOEC in aquatic systems. 1,1-DCE has a relatively low octanol/water partition coefficient (5.37) and a BCF range from 20 to 30, which indicates that 1,1-DCE may not accumulate significantly in animals (Lyman *et al.*, 1982). 1,1-DCE is not very toxic to freshwater or saltwater fish species, with acute LC50 values ranging from 80 to 200 mg/L (EPA, 1980).

cis-1,2-DCE and *trans*-1,2-DCE

1,2-DCE exists in two isomeric forms, *cis*-1,2-DCE and *trans*-1,2-DCE, that are colorless, volatile liquids with a slightly acrid odor. 1,2-DCE is prepared commercially by either the direct chlorination of acetylene or by the reduction of 1,1,2,2-TCA with fractional distillation used to separate the two isomers. 1,2-DCE can also be formed as a by-product during the manufacture of other chlorinated compounds. Commercial use is not extensive, but *trans*-1,2-DCE and mixtures of *cis*- and *trans*-1,2-DCE have been used as intermediates in the production of other chlorinated solvents and compounds, as well as low temperature extraction solvents for dyes, perfumes, and lacquers. Both *cis*- and *trans*-1,2-DCE are moderately flammable and react with alkalis to form chloroacetylene gas, which spontaneously ignites in air.

Information on the toxicity of 1,2-DCE in humans and animals is limited. Workers acutely exposed to 1,2-DCE have been reported to suffer from drowsiness, dizziness, nausea, fatigue and eye irritation. Acute and subchronic oral and inhalation studies of *trans*-1,2-DCE and acute inhalation studies of *cis*-1,2-DCE indicate that the liver is the primary target organ in animals; toxicity being expressed by increased activities of liver associated enzymes, fatty degeneration and necrosis. Secondary target organs include the central nervous system and lung.

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Limited information exists on the absorption, distribution, and excretion of 1,2-DCE in either humans or animals. *In vitro* studies have shown that the mixed function oxidizes will metabolize 1,2-DCE; the final metabolic products are dependent on the initial isomer of 1,2-DCE.

On the basis of an unpublished study describing decreased hemoglobin and hematocrits in rats treated by gavage for 90 days, EPA (1990a, b) assigned a subchronic and chronic oral RfD for cis-1,2-DCE of 1E-1 mg/kg/day and 1E-2 mg/kg/day, respectively. The RfDs were derived from a NOAEL Lowest Observed Adverse Affect Level (LOAEL) of 32 mg/kg/day. An inhalation RfC for cis-1,2-DCE has not been derived.

Subchronic and chronic RfDs of 2E-1 mg/kg/day and 2E-2 mg/kg/day, respectively, for trans-1,2-DCE have been calculated. The RfDs were derived from a LOAEL of 175 mg/kg/day based on the increase of serum alkaline phosphatase activity in mice that received trans-1,2-DCE in their drinking water. An RfC for trans-1,2-DCE has not been derived.

No information was available concerning the chronic, developmental or reproductive toxicity of cis-1,2-DCE or trans-1,2-DCE. No cancer bioassays or epidemiological studies were available to assess the carcinogenicity of 1,2-DCE. EPA has placed cis-1,2-DCE in weight-of-evidence Group D (not classifiable as to human carcinogenicity) based on the lack of human or animal carcinogenicity data and on essentially negative mutagenicity data. Trans-1,2-DCE has not been classified.

Because of its volatility, the primary route of 1,2-DCE exposure to humans is by inhalation, although dermal and oral exposure can occur. Exposure to 1,2-DCE may occur as a result of releases from production and use facilities, from contaminated waste disposal sites and wastewater, and from the burning of polyvinyl and vinyl copolymers. 1,2-DCE contaminates groundwater supplies by leaching from waste disposal sites. Therefore, human oral, dermal, and inhalation exposure can occur from drinking and using water, and by breathing vapors from 1,2-DCE-contaminated supplies and delivery systems.

Tetrachloroethene (PCE)

PCE is a halogenated aliphatic hydrocarbon. It is a colorless liquid with a molecular weight of 165.85 and a vapor pressure of 17.8 mm Hg at 25°C. PCE has a half-life of 47 days in the atmosphere and 30 to 300 days in surface water and groundwater. PCE is used primarily as an industrial solvent for a number of applications, and is routinely used in laundry and dry cleaning operations. Inhalation exposure is the primary concern for workers. The general public can also be exposed to PCE by inhalation, mainly in areas of concentrated industry and population. Some of the highest outdoor air levels (up to 58,000 ppt) have been associated with waste disposal sites. Exposure can also occur through contact with contaminated food and water supplies. An estimated 7 to 25 percent of the water supply sources in the United States may be contaminated with PCE.

The main targets of PCE toxicity are the liver and kidneys by both oral and inhalation exposure, and the central nervous system (CNS) by inhalation exposure. Acute exposure to high concentrations of the chemical (estimated to be greater than 1500 ppm for a 30-minute exposure) may be fatal. Chronic exposure causes respiratory tract irritation, headache, nausea, sleeplessness, abdominal pains, constipation, cirrhosis of the liver, hepatitis, and nephritis in

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humans; and microscopic changes in renal tubular cells, squamous metaplasia of the nasal epithelium, necrosis of the liver, and congestion of the lungs in animals.

RfDs for chronic and subchronic oral exposure to PCE are 0.1 mg/kg/day and 0.01 mg/kg/day, respectively (Buben and Flaherty, 1985; USEPA, 1990; 1991). These values are based on hepatotoxicity observed in mice given 100 mg PCE/kg body weight for 6 weeks and a NOAEL of 20 mg/kg.

Epidemiological studies of dry cleaning and laundry workers have demonstrated excesses in mortality due to various types of cancer, including liver cancer, but the data are regarded as inconclusive because of various confounding factors. The tenuous finding of an excess of liver tumors in humans is strengthened by the results of carcinogenicity bioassays in which PCE, administered either orally or by inhalation, induced hepatocellular tumors in mice. PCE was negative for tumor initiation in a dermal study and for tumor induction in a pulmonary tumor assay.

Based on the sufficient evidence from oral and inhalation studies for carcinogenicity in animals and no or inadequate evidence for carcinogenicity to humans, PCE is placed in EPA's weight-of-evidence Group B2 (probable human carcinogen). For oral exposure, the slope factor is $5.1 \times 10^{-2} \text{ (mg/kg/day)}^{-1}$; the unit risk is $1.5 \times 10^{-6} \text{ (mg/L)}^{-1}$. For inhalation exposure, the slope factor was calculated as 2.03×10^{-3} from the unit risk of $5.2 \times 10^{-7} \text{ (mg/m}^3\text{)}^{-1}$.

Trichloroethene (TCE)

TCE is a colorless, stable liquid with a chloroform like odor. It has a molecular weight of 131.5, a vapor pressure of 60mm Hg at 20°C, and a solubility of 1,100 mg/l at 25°C. TCE is considered slightly soluble in water and is miscible with common organic solvents. TCE is used as a metal degreaser, as an extraction solvent for oils, fats, and waxes, for solvent dyeing, in dry cleaning, and for cleaning and drying electronic parts.

Inhalation exposure is the most likely route for human contact with TCE. Systemic health effects have generally been reported only when people are exposed to TCE levels above the odor threshold. There are a few case reports of humans exhibiting kidney and liver damage following exposure to very large amounts of TCE.

There is no reliable information concerning the adverse systemic effects of chronic exposure to levels of TCE below the threshold limit value of 50 ppm. Neurological effects reported in workers exposed for less than 15 years to relatively high mean TCE levels (167 ppm) include vertigo, fatigue, headache, and short-term memory loss. The number of symptoms increased with cumulative exposure time.

EPA's IRIS database currently does not list a chronic oral or inhalation RfD for TCE. The chronic systemic toxicity of TCE is currently under review by the RfD Workgroup. Pending this review, a provisional chronic oral RfD of 6E-3 mg/kg-day was issued by ECAO (now NCEA) in 1992, based on the subchronic mouse study by Tucker, et al (1982). The critical effect seen in this study was liver toxicity following oral administration.

Animal studies have shown increases in cancers of various types following inhalation or oral

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exposure to TCE. These cancer types include cancer of the liver and forestomach in mice, and cancer of the kidney and testes in rats. It is believed that tumor production by TCE is the result of metabolites of TCE. There are differences between high- and low-dose metabolism of TCE, as well as differences between species' susceptibility to cancer. Given that enormous worker populations have been exposed to TCE, and that only a small number of persons have experienced chronic effects, it is possible that TCE is not metabolized to the active carcinogen level in humans at low environmental doses. The mechanisms of carcinogenicity are not known. EPA has classified TCE as a Class B2 (adequate evidence in animals but insufficient evidence in humans) carcinogen.

Mutagenesis studies have suggested that TCE is only very weakly genotoxic following metabolic activation. The Health Assessment Document concludes that there is insufficient evidence to prove that TCE is mutagenic.

1,1,2-Trichloroethane (1,1,2-TCA)

1,1,2-TCA is a colorless, sweet-smelling liquid that does not burn easily and boils at a higher temperature than water. It is used mostly where 1,1-DCE (vinylidene chloride) is made. 1,1,2-Trichloroethane is used as a solvent. 1,1,2-TCA can enter the body when a person inhales air containing the compound, or when a person drinks water containing this compound. It can also enter the body through the skin. After it enters the body, it is carried by the blood to organs and tissues such as the liver, kidney, brain, heart, spleen, and adipose (fat) tissue. Experiments in which animals were given 1,1,2-TCA by mouth have shown that most of the compound leaves the body unchanged in the breath and as other metabolites in the urine in approximately one day. Very little 1,1,2-TCA stays in the body for more than two days.

1,1,2-TCA can cause temporary stinging and burning pain on the skin. There is no other information on the health effects of 1,1,2-TCA in humans. Short-term exposure to high levels in the air or high doses given by mouth or applied to the skin has caused death in animals. Long-term exposure of animals to high doses given by mouth has also shortened the lifespan. Breathing high levels in air can affect the nervous system and cause sleepiness. 1,1,2-TCA may also affect the liver, kidney, and digestive tract, produce skin irritation, and affect the immune system. Mice, but not rats, that were given high doses of 1,1,2-TCA by mouth for most of their life developed liver cancer, but we do not know whether humans exposed to this chemical would develop cancer (ATSDR, 1989b). The U.S. EPA has classified 1,1,2-TCA as a group, possible human carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).

In wastewater treatment plants that receive refractory volatile compounds, such as 1,1,2-TCA, from industrial discharges or other sources, stripping will be an important mechanism for transferring the chemical from the water into the air. 1,1,2-TCA will not adsorb appreciably to soil, sediment, and suspended solids in the water column and would be expected to readily leach into the subsurface soil and ground water. The bioconcentration factors for 1,1,2-TCA are low; therefore, it would not be expected to bioconcentrate in fish to any great extent (ATSDR, 1989b).

Lead

Lead is a commonly used, naturally occurring metal which is ubiquitous in the environment.

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Lead is found in construction materials, leaded gasoline, radiation protection gear, paint, ceramics, plastics, and ammunition. Lead is well absorbed from the respiratory tract, including the nasal passages. Absorption from the gastrointestinal tract is less rapid and complete than from the respiratory tract. Dermal absorption is a much less significant route of exposure than inhalation or ingestion. Absorbed lead is distributed to the soft tissues of the body with the greatest distribution to the kidneys and the liver. Lead is eventually transferred to the skeleton where 90% of the body's long-term burden is stored. The portion of lead that is not absorbed is excreted in the feces. Most of the absorbed lead is excreted in the urine or through biliary clearance into the gastrointestinal tract (ATSDR, 1988).

Lead intoxication in humans can occur by ingestion and inhalation of dust or fumes. Symptoms of lead intoxication include anorexia, malaise, headaches and intestinal spasms. The neuromuscular disease, lead palsy, is a result of advanced subacute poisoning (lead blood levels of 70 $\mu\text{g/dL}$ and less), and is characterized by muscle weakness leading to paralysis. Lead encephalopathy is the term used for the central nervous system manifestation which is commonly seen in children when lead blood levels reach 90 $\mu\text{g/dL}$. Symptoms include clumsiness, dizziness, delirium, convulsions and coma. The mortality rate is 25% when the brain is involved, with survivors suffering long-term neurological problems (ATSDR, 1988; HSDB, 1988; IRIS, 1994; USDHHS, 1991).

Chronic low level lead exposure (lead blood levels of 30-50 $\mu\text{g/dL}$) is associated with learning disabilities. Lead toxicity is defined by the Centers for Disease Control as a blood level of 25 $\mu\text{g/dL}$ or greater in a child. Damage at lower levels has been reported and the blood level will be revised to approximately 10-15 $\mu\text{g/dL}$. Kidney damage occurs after prolonged exposure, and is apparently reversible. In epidemiological studies, lead intoxication is also associated with increased blood pressure which is symptomatic of kidney damage. Lead exposure is associated with reproductive effects such as miscarriages and temporary sterility. Lead readily crosses the placenta. Occupational exposure to airborne lead is associated with an increased incidence of total malignant neoplasms, cancers of the digestive tract and cancers of the respiratory tract. An increased incidence in kidney cancer was seen in lead smelter workers exposed by inhalation and in various animal species exposed by ingestion at levels of 500 ppm and above. The USEPA has classified lead as a group B2 carcinogen based on animal studies (probable human carcinogen with inadequate or no evidence in humans) (ATSDR, 1988; HSDB, 1988; IRIS, 1994; USDHHS, 1991).

The mobility of lead in soil is dependent on the chemical properties of the soil. Lead can react with sulfates, carbonates and phosphates or combine with clays and organic matter which limits the further migration of lead through the soil matrix. Lead in surface waters is usually present as suspended solids. Atmospheric lead is removed by dry deposition and rainout. Lead does not significantly bioaccumulate in fish. Lead localizes in fish skin which serves to reduce human exposures by fish consumption. Lead is toxic to wildlife, particularly water fowl, through their consumption of lead shot. Tetraethyl lead is biodegradable, but inorganic lead concentrations above 5 $\mu\text{g/L}$ can be toxic to microorganisms. As water hardness increases, the acute toxicity of lead to freshwater aquatic species decreases (ATSDR, 1988; HSDB, 1988; IRIS, 1994; USDHHS, 1991).